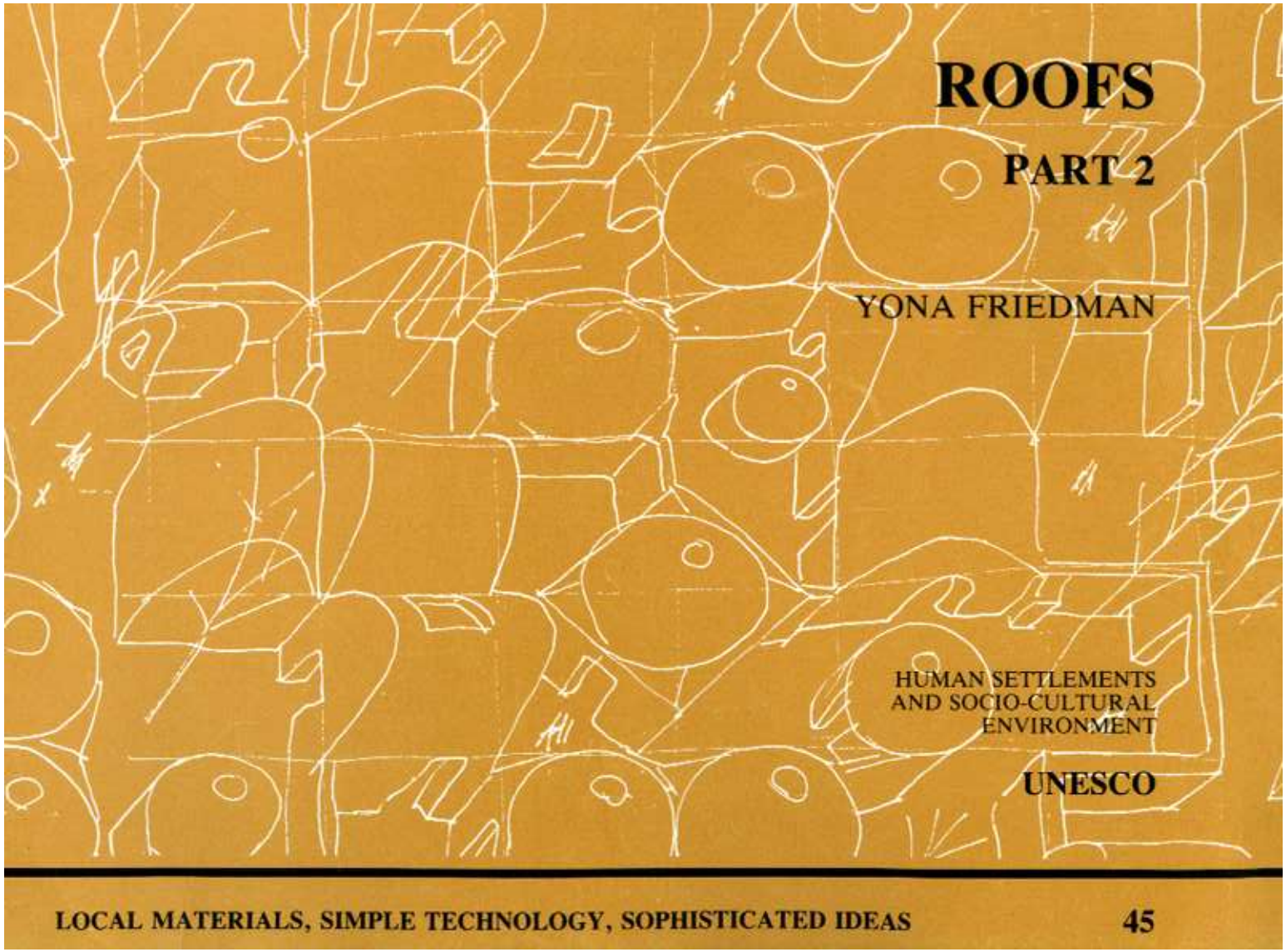

ROOFS
PART 2
YONA FRIEDMAN
HUMAN SETTLEMENTS
AND SOCIO-CULTURAL
ENVIRONMENT
UNESCO
LOCAL MATERIALS, SIMPLE TECHNOLOGY, SOPHISTICATED IDEAS
45

ROOFS

PART 2

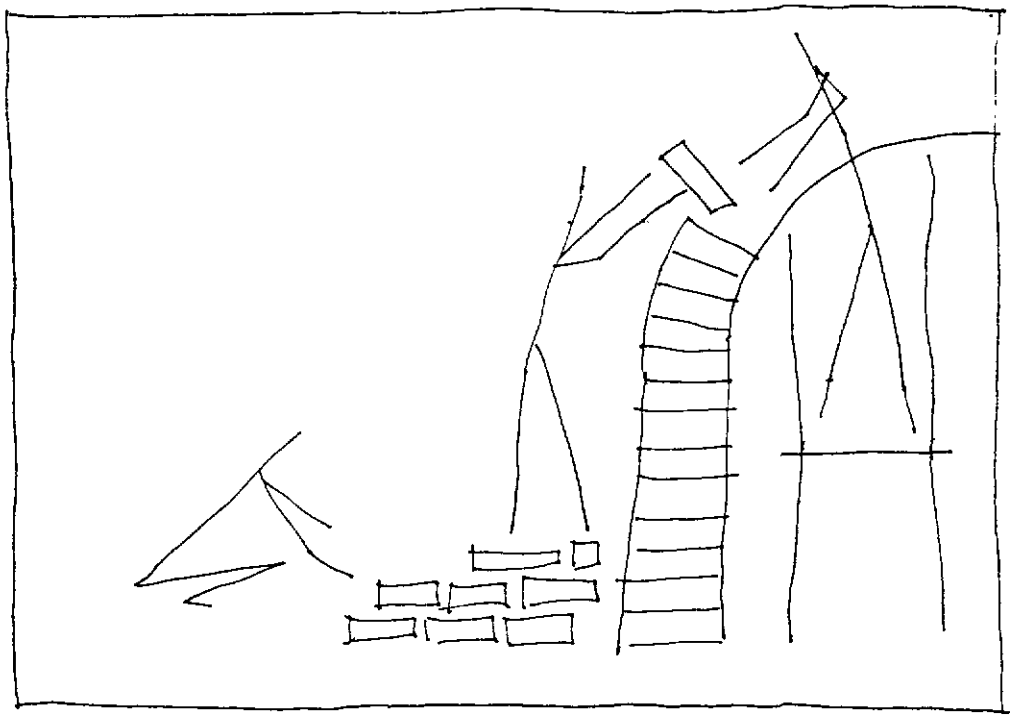
YONA FRIEDMAN

HUMAN SETTLEMENTS
AND SOCIO-CULTURAL
ENVIRONMENT

UNESCO

COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS



ROOFS MADE WITH MINERAL MATERIALS

THIS WORK WAS CARRIED OUT WITH A GRANT FROM THE
INTERNATIONAL DEVELOPMENT RESEARCH CENTRE,
OTTAWA, CANADA

In July 1991, "Roofs for People" by Yona Friedman and Eda Schaur, was awarded among 3068 entries, the Grand Prize/Prime Minister's Prize at the 5th International Design Competition, Osaka, promoted by the Japan Design Foundation.

The jury's comments are as follows:

"This work is a proposal for the construction of dwellings at low cost to house poor and illiterate people. Underlying the proposal is a most topical message involving criticism of the rationalistic mindset of modern people.

The proposal presents a method by which people could build houses for themselves at low cost using materials available in their own region; instruction manuals using "picture scripts" would be provided for those unable to decipher technical drawings. The proposal is an attempt to solve a highly important and pressing problem for hundreds of millions of people in the world who subsist on low incomes.

As well, the work seems to contain a valuable message: it prompts reflection on the fact that various problems related to modern cities have resulted from neglectful attitudes towards the earth".

COMMUNICATION CENTRE
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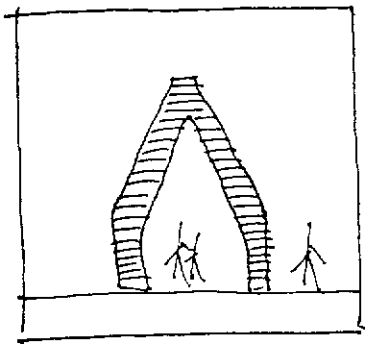
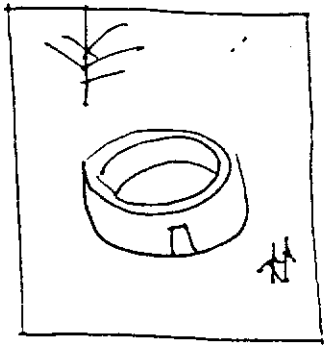
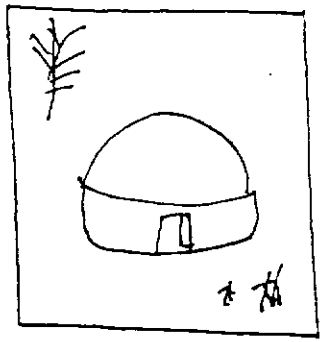
33, BD GARIBALDI, 75015 PARIS ☎ (331) 783-20-24

FALSE DOMES

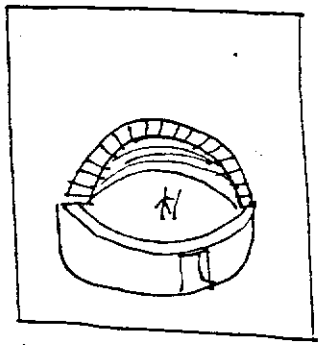




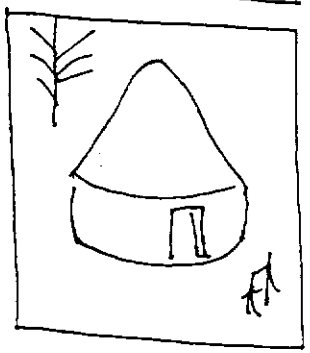
IF YOUR HOUSE
CAN BE BUILT ON A CIRCULAR PLAN,



IT IS EASY TO COVER IT
WITH A DOME.

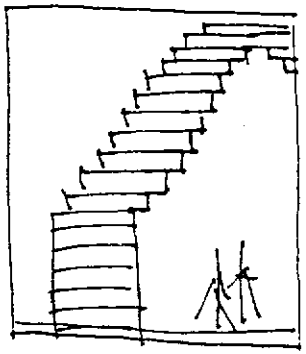


A DOME
IS A VAULT ON A RING-SHAPED WALL.

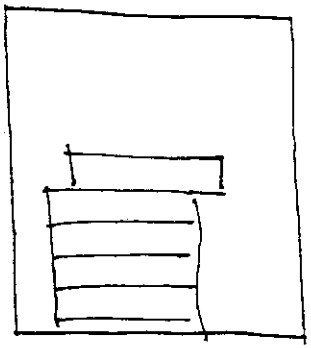


BUT EVEN EASIER TO BUILD

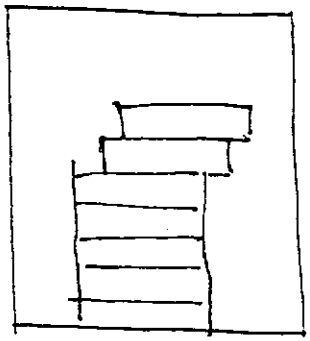
IS A "FALSE DOME".



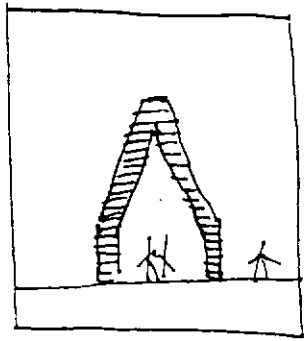
A "FALSE VAULT"
IS BUILT WITH BRICKS,



WITH EACH ROW OF BRICKS
PROTRUDING SLIGHTLY

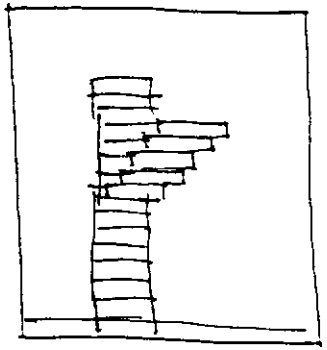


BEYOND THE ROW BELOW IT.

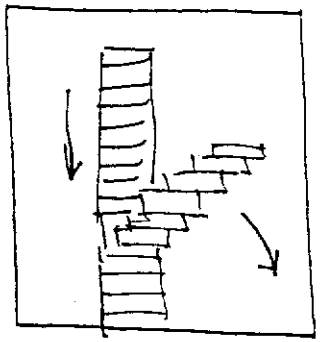


THIS ARRANGEMENT,
REPEATED ROW BY ROW,

CREATES A FALSE VAULT.

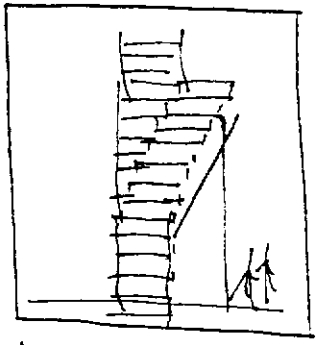


WHEN BUILDING A FALSE VAULT



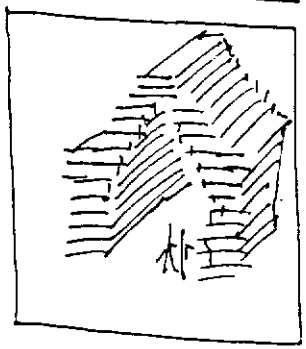
IT IS IMPORTANT TO WEIGHT DOWN THE WALL

(WHICH HAS TO BE PRETTY THICK)

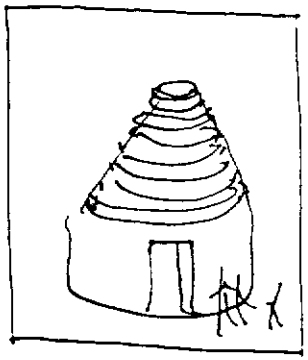


AND EACH ROW OF BRICKS. SHOULD BE KEPT BY A TEMPORARY SUPPORT,

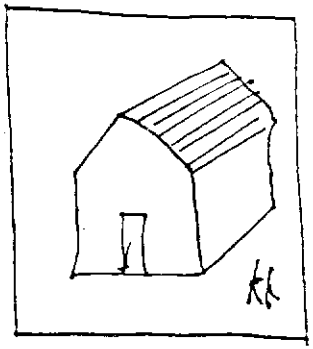
WHICH CAN BE TAKEN AWAY WHEN THE VAULT IS READY.



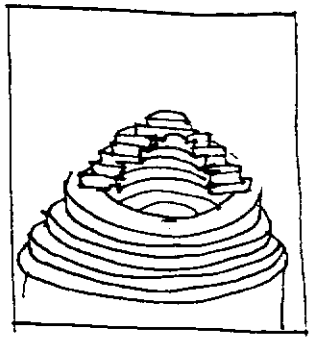
WITHOOT THAT PRECAUTION THE VAULT WILL FALL IN.



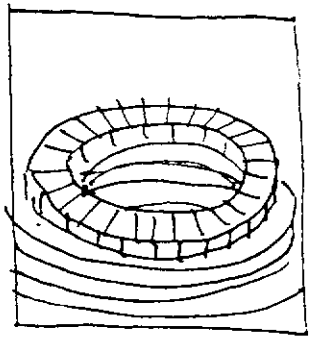
BUT A FALSE DOME ON A CIRCULAR PLAN



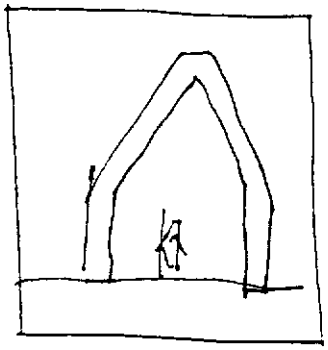
IS EASIER TO BUILD THAN A FALSE VAULT.



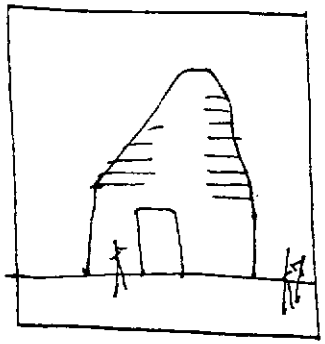
THIS COMES FROM THE ROWS OF BRICKS BEING CIRCULAR,



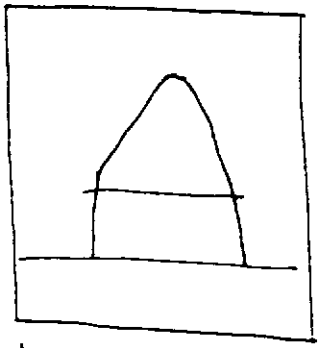
THUS EACH BRICK KEEPING ITS NEIGHBOUR FROM FALLING IN.



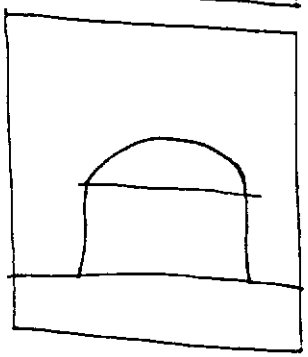
SUCH A FALSE DOME
CAN BE UP TO 10 FEET LARGE



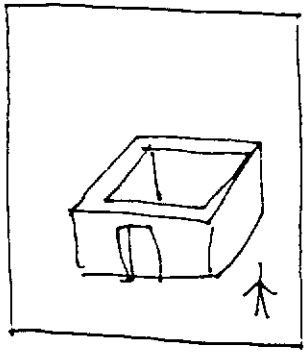
AND HAS TO BE
AT LEAST AS HIGH
AS IT IS LARGE



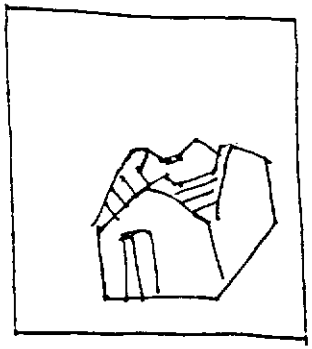
THUS IT WILL BE
MUCH STEEPER



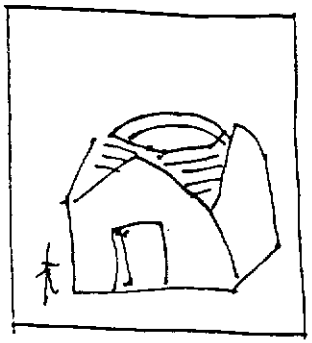
THAN A REGULAR DOME.



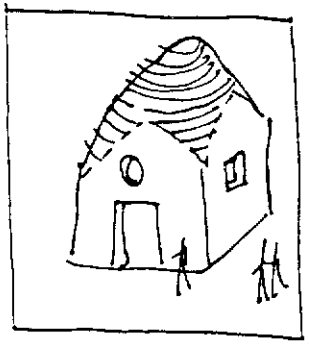
SUCH A FALSE DOME
CAN BE EVENTUALLY BUILT
OVER A SQUARE PLAN TOO:



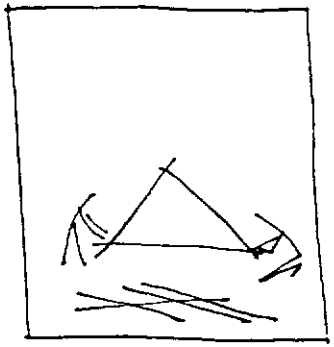
FIRST YOU HAVE TO START
THOSE PROTRUDING ROWS OF BRICKS
IN THE CORNERS,



TILL THE PROTRUDING ROWS
BECOME LIKE A CIRCULAR BELT.

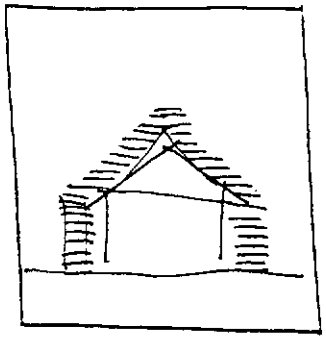


THEN, UPON THAT BELT,
YOU CAN CONTINUE
THE FALSE DOME ON CIRCULAR PLAN.

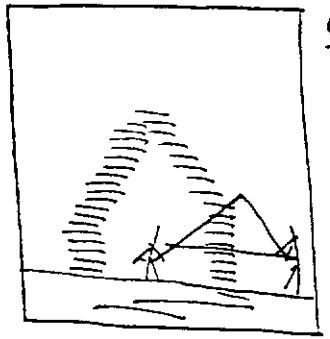


ANOTHER WAY
TO BUILD A FALSE VAULT

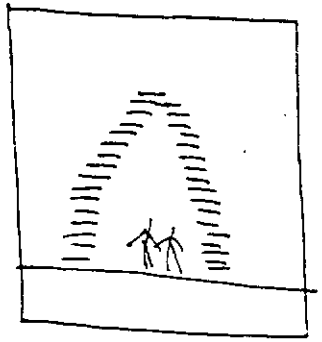
INVOLVES THE USE OF SCAFFOLDING.



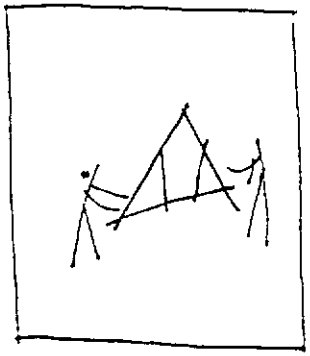
A SIMPLE SCAFFOLDING
PREVENTS THE VAULT FROM FALLING IN
BEFORE IT IS COMPLETED.



ONCE THE VAULT IS FINISHED
THE SCAFFOLDING CAN BE REMOVED:

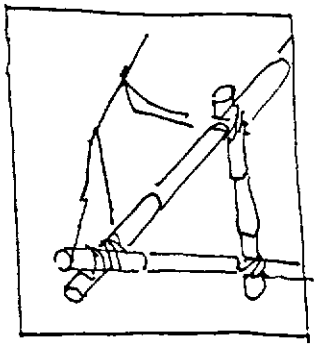


THE VAULT WILL REMAIN IN PLACE
WITHOUT IT.

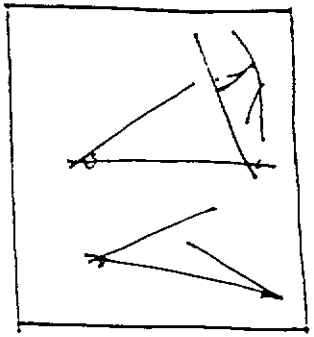


SCAFFOLDING
FOR A FALSE VAULT
CONSISTS OF A SOLID TRIANGLE

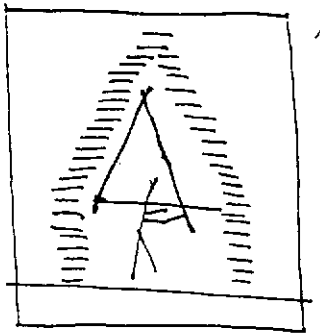
SHAPED ACCORDING TO
THE DESIRED SHAPE OF THE FALSE VAULT,



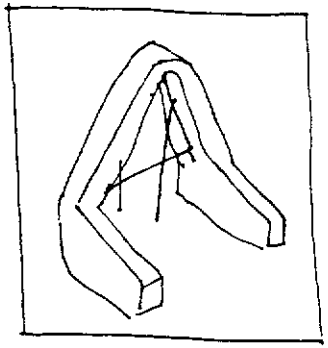
MADE OF BAMBOO
OR OTHER SIMILAR MATERIAL.



THAT TRIANGLE IS MADE SO
THAT PARTS OF IT
CAN BE DISMOUNTED

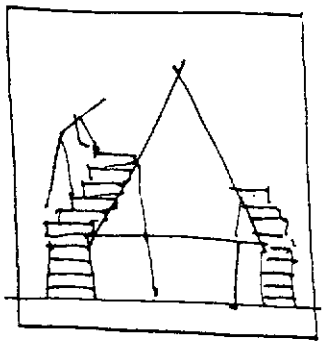


AND THE SCAFFOLDING REMOVED
FROM UNDER THE FINISHED VAULT.

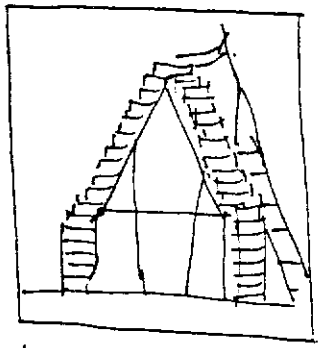


THE PROCEDURE IS SIMPLE:

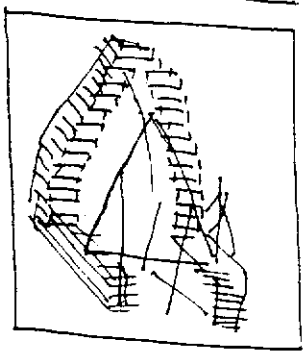
AFTER SETTING UP
THE SCAFFOLDING,



A PORTION OF THE FALSE VAULT
CAN BE BUILT
WITH EACH BRICK LEANING
ONTO THE SCAFFOLDING.

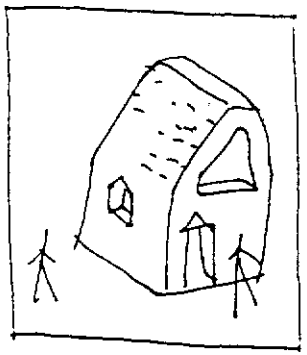


ONCE THE LAST BRICKS
ARE PUT INTO THEIR PLACE

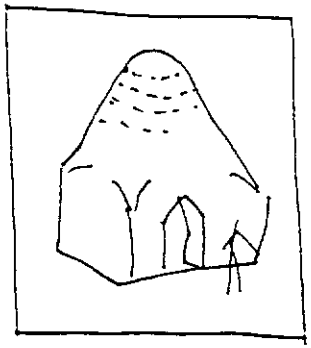


THE VAULT IS SOLID ENOUGH
AND THE SCAFFOLDING
CAN BE TAKEN

TO UNDER THE NEXT PORTION.

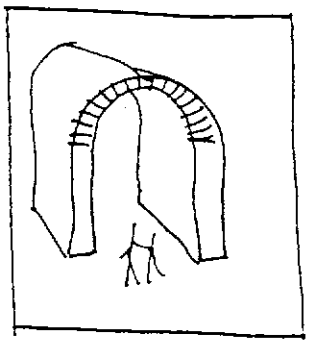


IT IS EASY TO BUILD
A FALSE VAULT

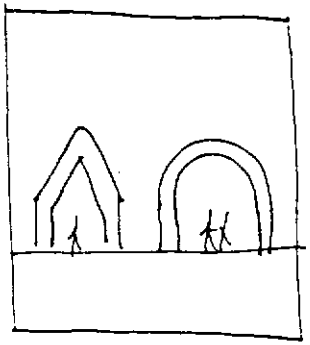


OR A FALSE DOME.

WITH
OR WITHOUT A SCAFFOLDING.



MUCH EASIER
THAN TO BUILD A REAL VAULT
OR A REAL DOME,



BUT IT CAN COVER
ONLY A LIMITED AREA,.

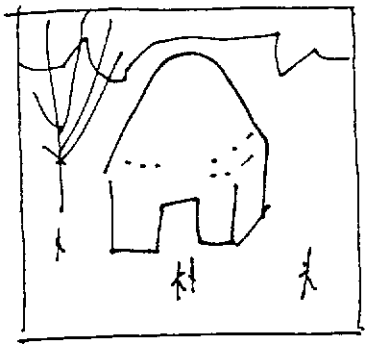
SMALLER THAN THAT OF A REAL VAULT
OR A REAL DOME.

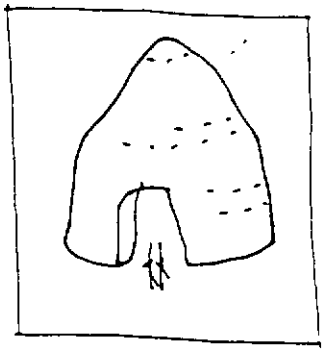
COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

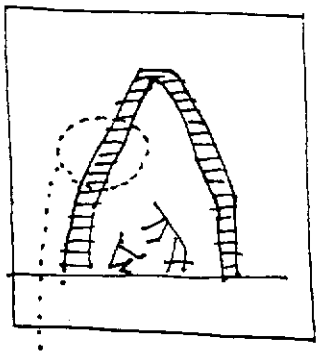
33, BD GARIBALDI, 75015 PARIS ☎ (331) 783-20-24

CONIC DOMES

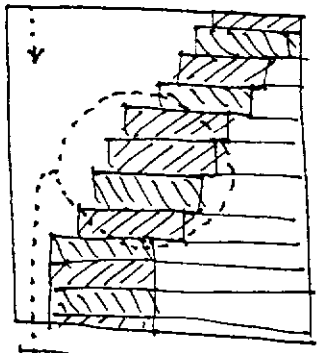




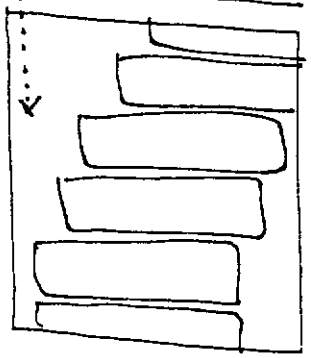
THE SIMPLEST KIND OF DOMES ARE THE CONIC DOMES.



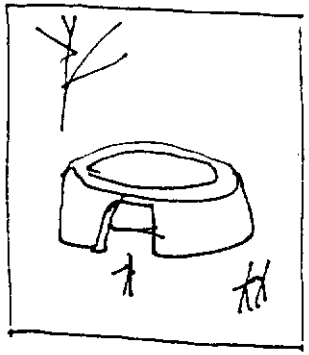
THEY CAN BE BUILT EASILY WITH THE SAME TECHNIQUE AS FALSE DOMES.



THAT MEANS, THAT EACH ROW OF STONES OR BRICKS

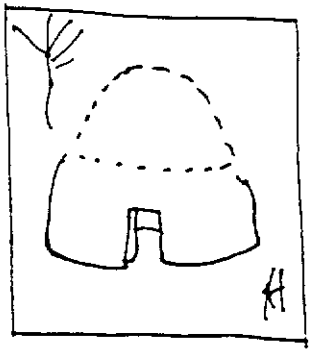


SHOULD PROTRUDE SLIGHTLY INWARD, OVER THE ROW BENEATH.

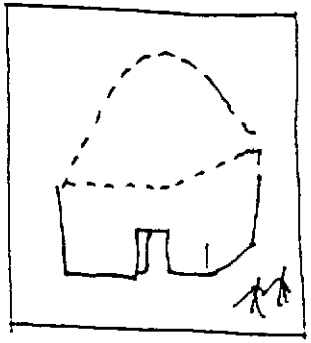


TO BUILD SUCH A DOME THE BEST SHAPE IS

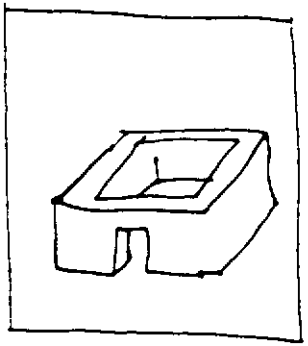
A CIRCULAR SHOULDER-LINE,



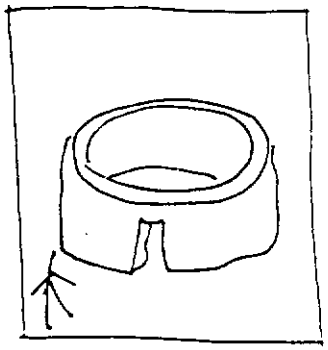
THUS, FOR EXAMPLE, A ROUND HOUSE.



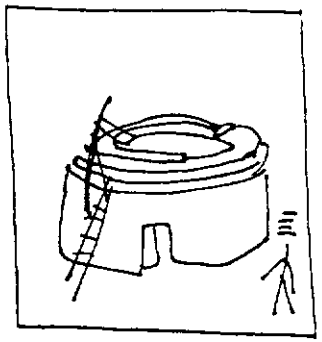
BUT, A SIMILAR STRUCTURE CAN BE BUILT



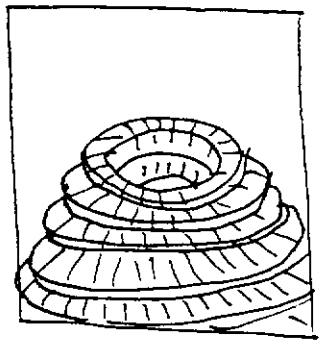
OVER A SQUARE DESIGN TOO.



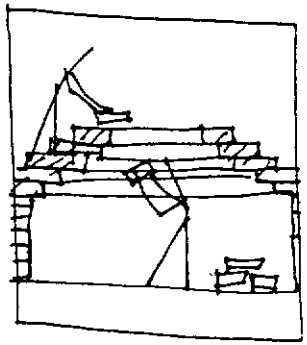
ONCE YOU HAVE DEFINED
THE SHOULDER-LINE,
FOR EXAMPLE, A CIRCULAR ONE,



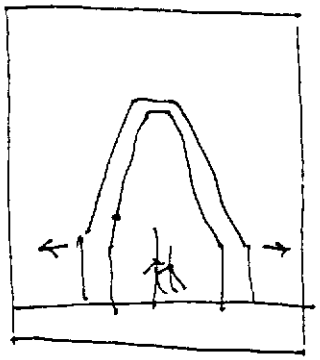
YOU CAN CONTINUE TO BUILD
ROW AFTER ROW,



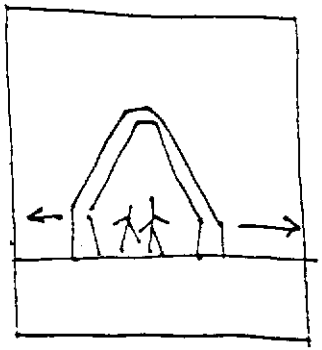
EACH CIRCLE BEING SMALLER



THAN THE CIRCLE BENEATH IT.

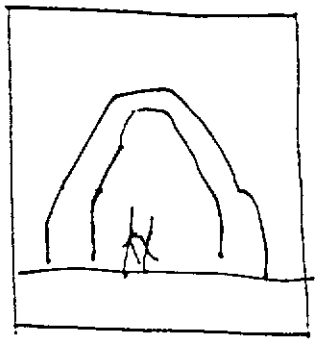


THE CONIC DOME,
(LIKE ALL VAULTS OR DOMES)

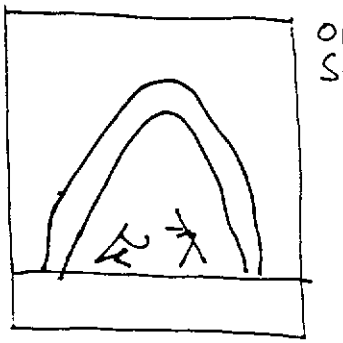


EXERCES A STRONG
SIDE PRESSURE.

THK DEPENDS
UPON ITS "SLENDERNESS".



THAT PRESSURE CAN BE COMPENSATED
WITH MAKING THE WALLS
VERY THICK,



OR MAKING THEM LEAN
SLIGHTLY INWARD.

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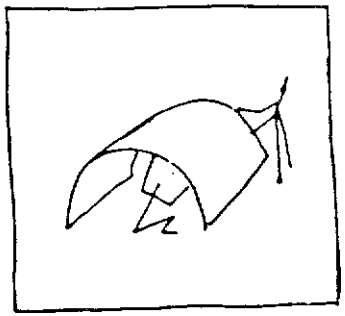
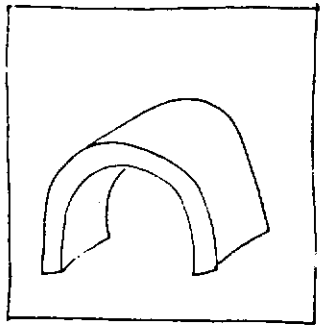
SIMPLE WAYS TO BUILD A VAULT

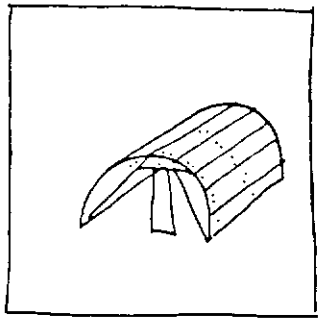
YONA FRIEDMAN



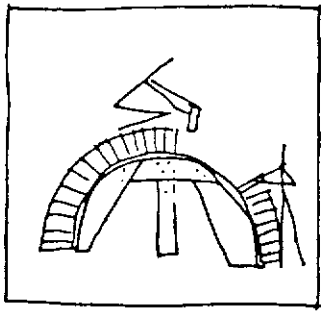


A VAULT RESEMBLES
A CURVED WALL

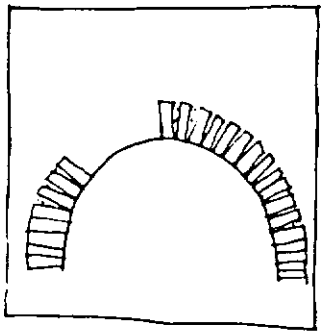
WHICH CAN BEAR A LOAD
BECAUSE ITS SHAPE.



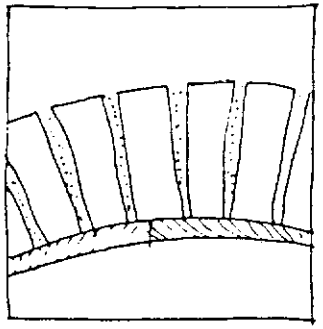
A VAULT CAN BE BUILT OF BRICKS,
OVER A SCAFFOLDING
OF SEMI-CIRCULAR FORM.



THE BRICKS SHOULD BE POSED
ON THE SCAFFOLDING
WITH THEIR SMALL END DOWNWARDS.

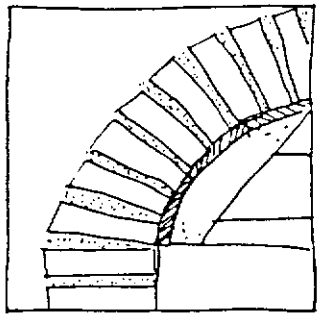


SO ALL BRICKS WOULD POINT
IN A DIRECTION
SLIGHTLY DIFFERENT THAN THAT OF THEIR NEIGHBOURS.

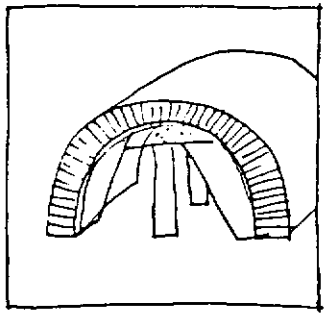


WHEN YOU ARRANGE BRICKS
FOR BUILDING A VAULT

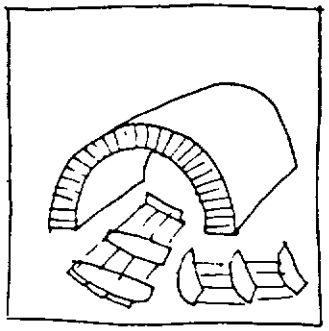
YOU HAVE TO PUT PLENTY OF MORTAR
BETWEEN ANY TWO BRICKS



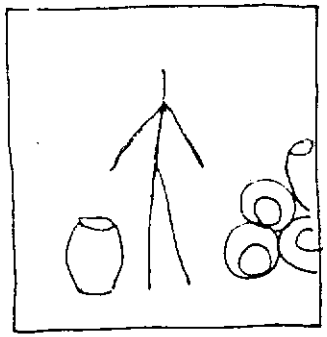
LIKE
WHEN YOU BUILD A WALL.



WHEN THE MORTAR IS HARD
AND THE VAULT IS SOLID

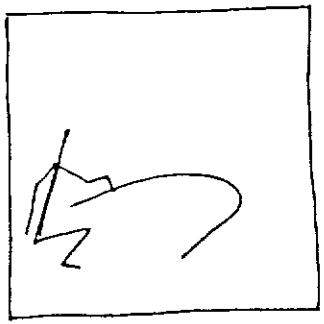


YOU CAN TAKE THE SCAFFOLDING
AWAY.



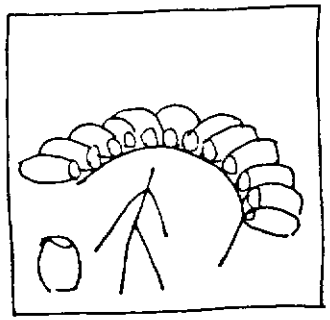
YOU CAN SOMETIMES
BUILD A VAULT WITHOUT SCAFFOLDING.

FOR THIS PURPOSE
YOU USE CERAMIC JARS
INSTEAD OF BRICKS (THEY ARE LIGHTER).



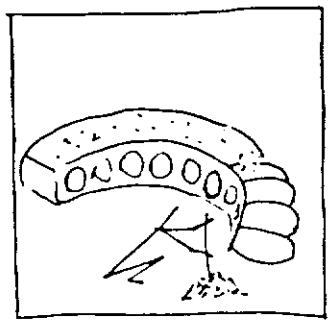
FIRST YOU DRAW ON THE GROUND
THE LINE WHICH WILL DETERMINE
THE PROFILE OF THE VAULT,

AND YOU DO THIS ON THE SPOT
WHERE YOU WANT TO BUILD THE VAULT.



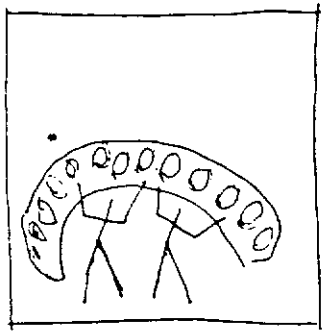
THEN YOU PLACE ONE ROW OF JARS
ALONG THIS LINE
(BUT ONLY ONE ROW).

THE JARS SHOULD BE PLACED
WITH THEIR SMALL END TOWARDS THE CENTRE.

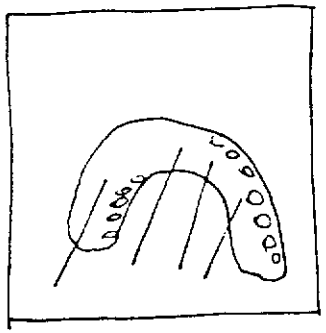


THE JARS HAVE THEN TO BE FIXED
WITH PLASTER
ALONG THE PROFILE

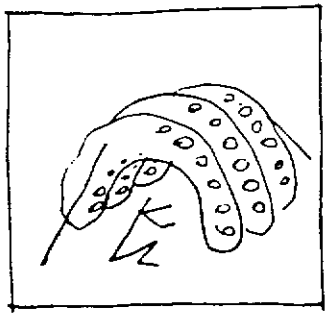
AND LEFT TO DRY.



ONCE THE ARCH BECOMES RIGID
AS THE PLASTER HARDENS,

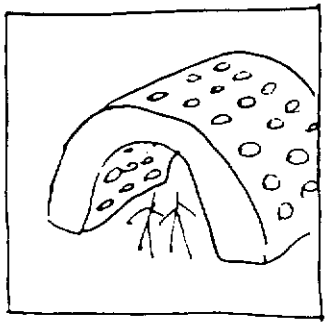


YOU CAREFULLY LIFT THE ARCH
IN VERTICAL POSITION
AND PROP IT UP WITH SOME STICKS,



THEN START IMMEDIATELY THE NEXT ARCH.
WHEN YOU FINISHED THE NEXT ARCH,
YOU LIFT IT IN POSITION
AS NEAR AS YOU CAN
TO THE PRECEDING ONE.

THEN YOU FIX THE NEW ARCH
TO ITS NEIGHBOUR WITH SOME PLASTER.



SO, FROM ARCH TO ARCH
YOU WILL BUILD YOUR VAULT,
WHICH WILL CONSIST OF A ROW OF ARCHES.

THIS VAULT WILL BE, EVIDENTLY,
WEAKER THAN AN ARCH MADE OF BRICKS.

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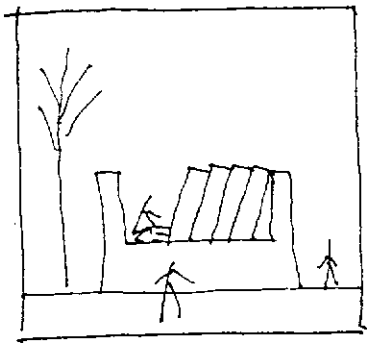
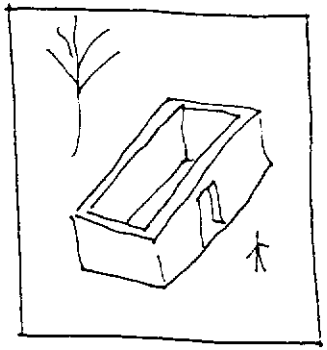
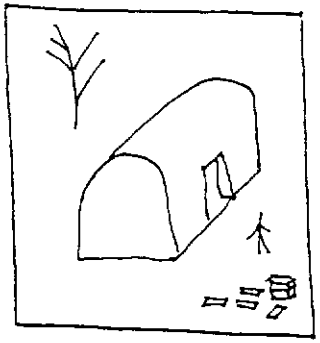
33, BD GARIBALDI, 75015 PARIS ☎ (331) 783-20-24

VAULTS WITHOUT SCAFFOLDING



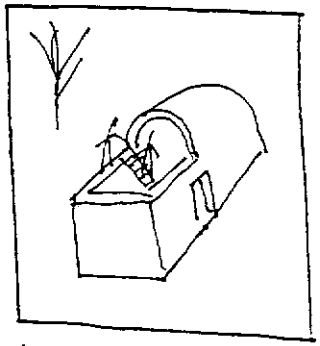


TO COVER YOUR HOUSE

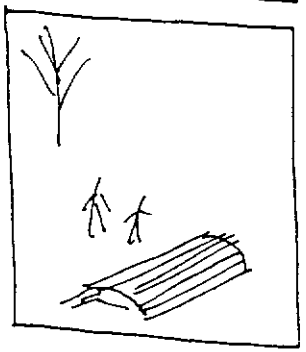


YOU CAN BUILD
A SIMPLE VAULT

WITH SUN-DRIED BRICKS.

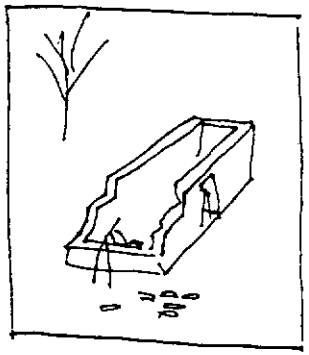


YOU CAN DO SO
WITHOUT ANY SPECIAL SCAFFOLDING
EXCEPT A LADDER.

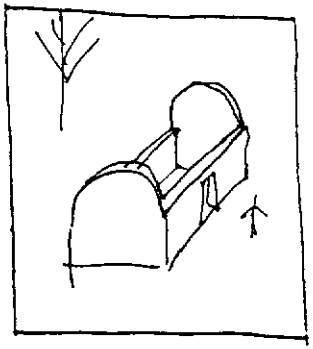


THIS IS PARTICULARLY IMPORTANT
AS SCAFFOLDING IS EXPENSIVE,

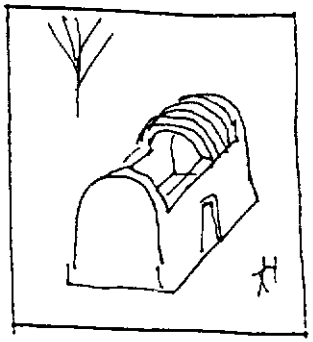
AS IT USES A LOT OF WOOD



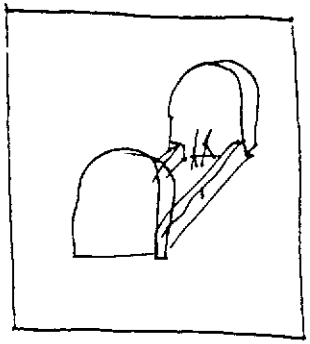
FIRST OF ALL
YOU HAVE TO BUILD THE WALLS
OF THE HOUSE.



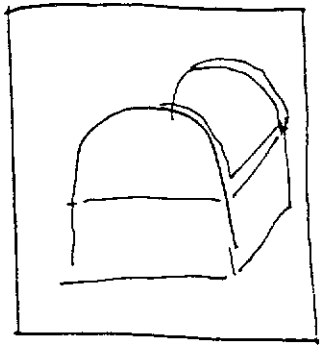
YOU SHOULD BUILD A GABLE
ON EACH OF TWO OPPOSITE WALLS.



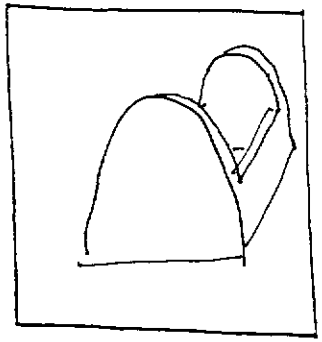
THE PROFILE OF THOSE GABLES
WILL DETERMINE
THE SHAPE OF THE VAULT TO BUILD.



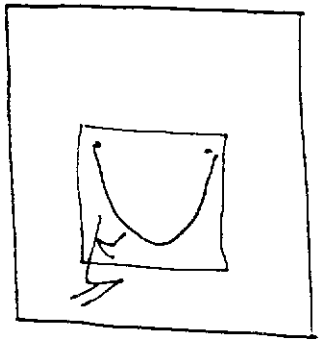
IT IS WISE TO DISPOSE THE GABLES
IN SUCH A WAY
THAT MAKES THE VAULT
HAVE THE LESSER SPAN.



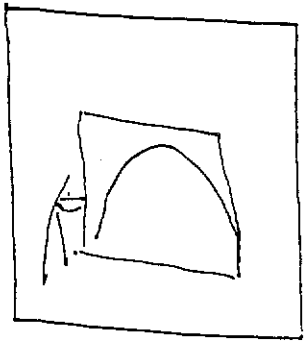
THE BEST FORM FOR A VAULT
IS NOT THE HALF OF A CIRCLE,



BUT A FIGURE CALLED "PARABOLA".

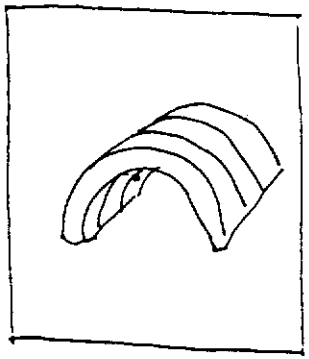


YOU CAN DRAW THAT FIGURE
BY COPYING
A FREELY HANGING ROPE OR CHAIN.



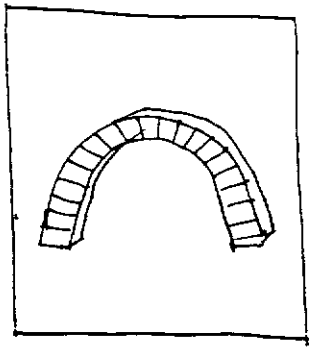
TURNING THAT DRAWING
UPSIDE DOWN

YOU GET THE SHAPE OF THE GABLE.

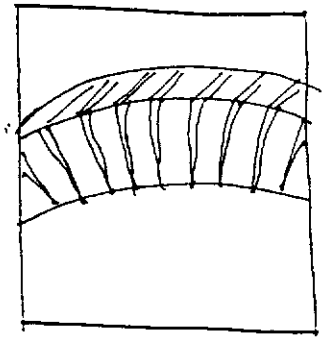


THE TECHNIQUE
FOR BUILDING A VAULT

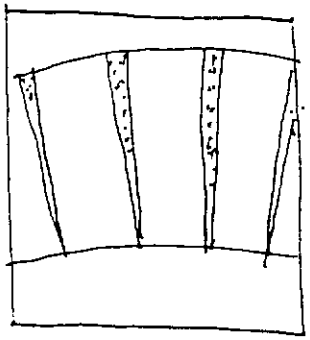
IS BY BUILDING
A ROW OF ARCHES.



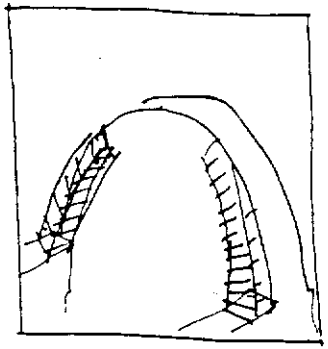
AS FOR AN ARCH,
IT IS SOLID
BECAUSE OF THE PATTERN
ACCORDING TO WHICH THE BRICKS ARE JOINED:



BETWEEN EACH COUPLE OF BRICKS
THERE IS A NARROW
TRIANGULAR INTERSTICE

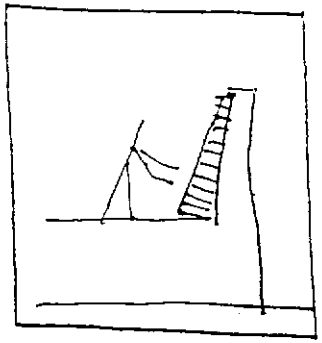


FILLED IN WITH MORTAR.



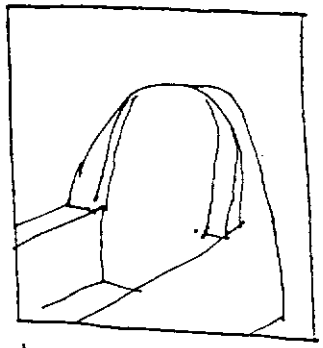
YOU SHOULD START TO BUILD THE FIRST ARCH

(FOLLOWING THE LINE OF THE GABLE)

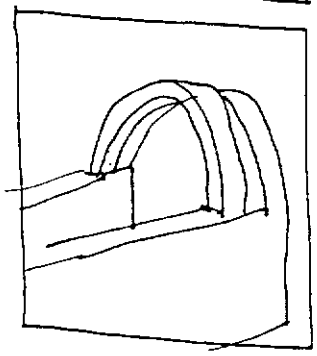


SO THAT IT LEANS AGAINST THE GABLE.

FIX IT TO THE GABLE WITH MORTAR.

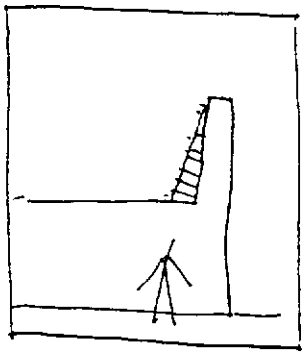


THIS FIRST ARCH WILL NOT BE A COMPLETE ONE,



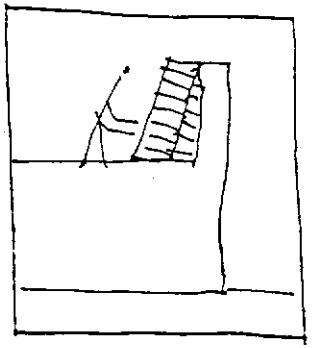
BUT THE SECOND WILL BE COMPLETE,

AND SO WILL BE ALL THE OTHERS



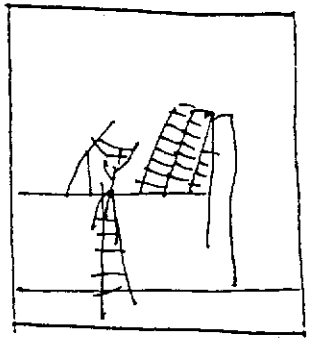
THUS, THE FIRST INCOMPLETE ARCH WILL LEAN AGAINST THE GABLE,

FIXED TO IT WITH MORTAR.

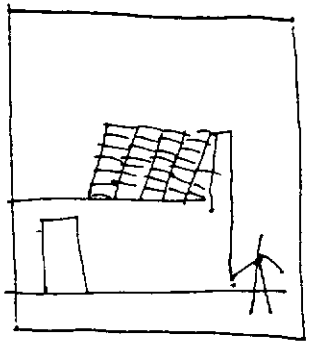


THE SECOND (COMPLETE) ARCH WILL LEAN AGAINST THE FIRST ONE,

FIXED TO IT WITH MORTAR.

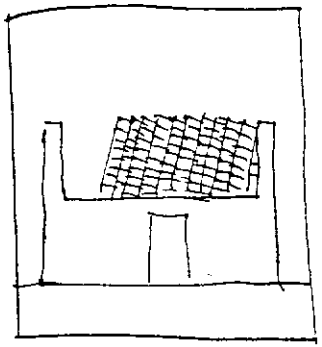


THE THIRD ARCH SHOULD LEAN AGAINST THE SECOND,

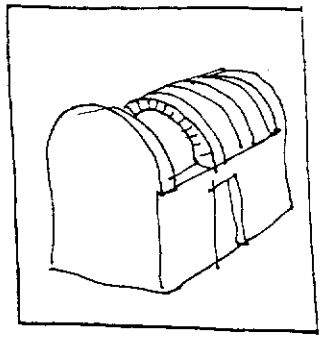


THE FOURTH AGAINST THE THIRD,

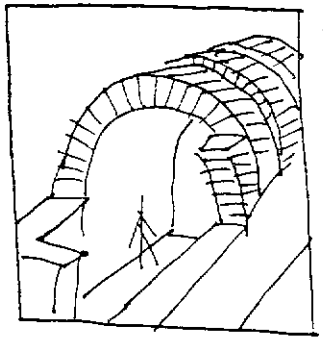
AND SO ON.



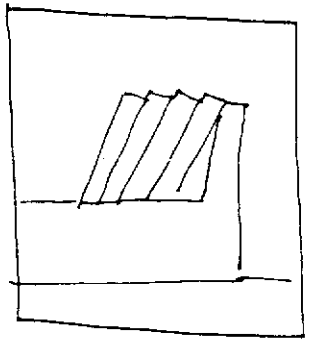
ALL THESE ARCHES,
EACH LEANING ON THE OTHER,



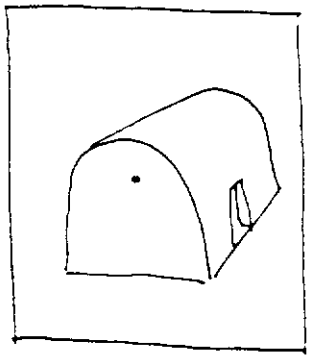
WILL KEEP TOGETHER,



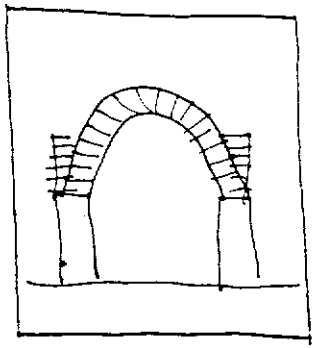
AND THE VAULT REMAIN IN PLACE
DURING THE BUILDING PERIOD



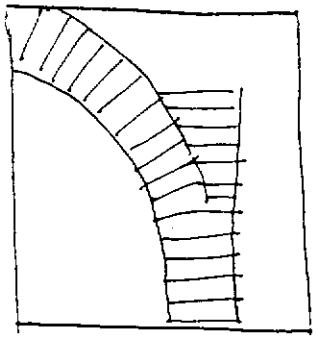
WITHOUT ANY SCAFFOLDING.



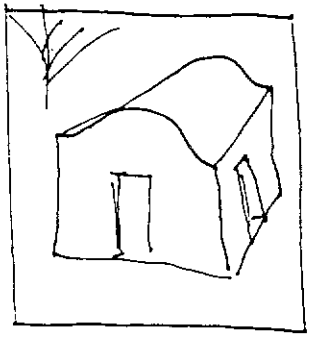
THE VAULT WILL BE MORE SOLID



IF YOU WEIGH DOWN
ITS SHOULDER-LINE



BY CONTINUING TO HEIGHTEN THE WALL
WITH A FEW ROWS OF BRICKS.



THIS VAULT WILL BE A GOOD ROOF
FOR YOUR HOUSE,

BUT FIRST YOU HAVE
TO MAKE IT WATER TIGHT.

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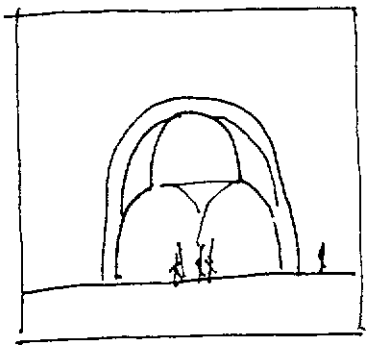
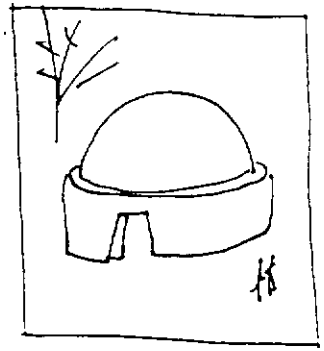
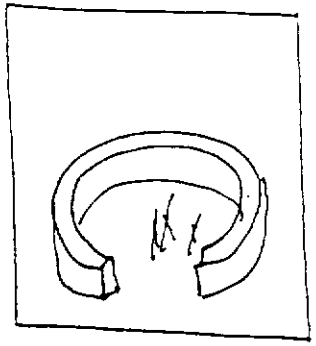
SUSPENDED DOMES

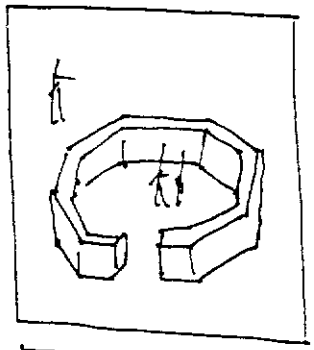




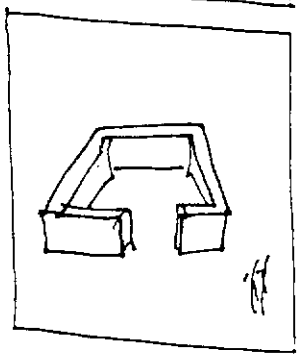
YOU KNOW
HOW TO BUILD A DOME



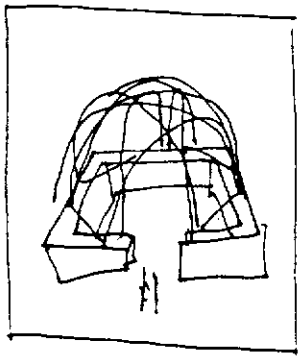
OVER A CIRCULAR LAYOUT,



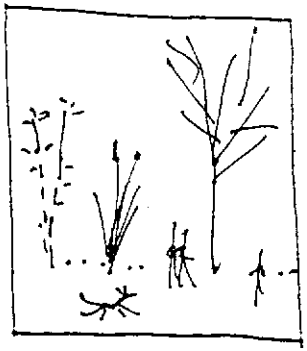
OR OVER AN OCTOGONAL ONE.



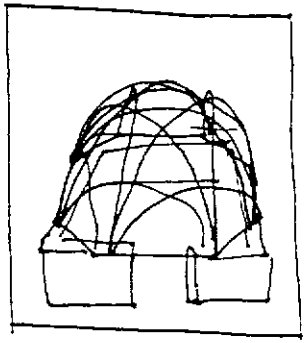
BUT, HOW TO BUILD SUCH A DOME
OVER A RECTANGULAR HOUSE?



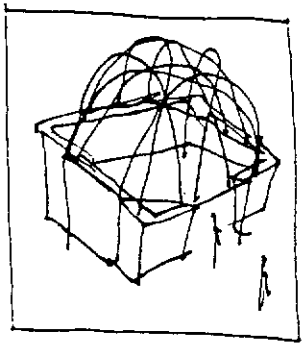
IF YOU BUILD THAT DOME
WITH MATERIALS OF VEGETAL ORIGIN,



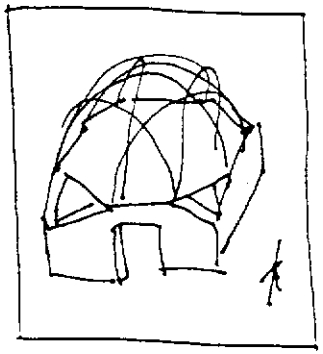
LIKE BAMBOO, REED OR WOOD,



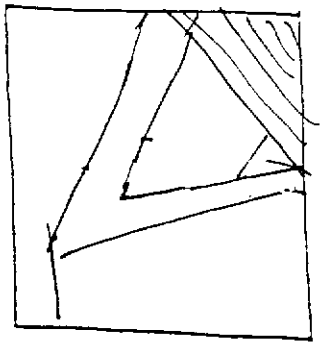
YOU CAN PROCEED
AS YOU WOULD DO
OVER AN OCTOGONAL LAYOUT,



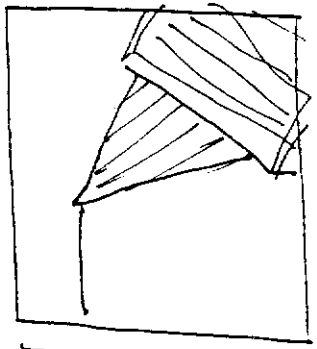
FOUR SIDES OF THE DOME
RESTING ON THE WALLS.



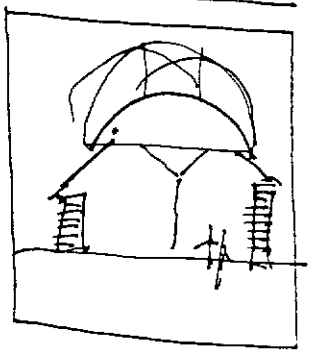
YOUR DOME WILL THEN COVER THE SQUARE ROOM.



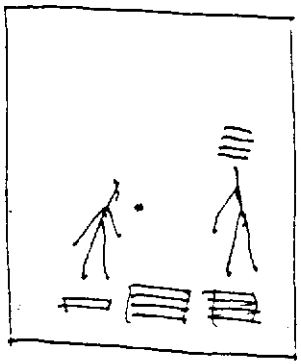
BUT, IN EACH OF THE 4 CORNERS A TRIANGULAR SPACE WILL REMAIN UNCOVERED



YOU SHOULD COVER THOSE 4 TRIANGLES WITH SLOPING ROOFLETS (CALLED "PENDENTIVES");

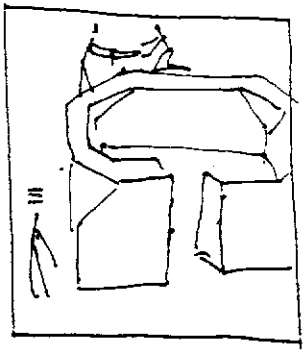


THE UPPER EDGE OF EACH ROOFLET SHOULD BE COVERED BY THE LOWER EDGE OF THE DOME.

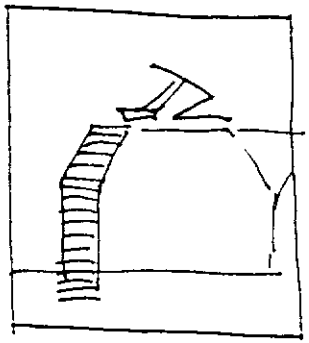


IF YOU BUILD THE DOME WITH BRICKS, BAKED OR UNBAKED.

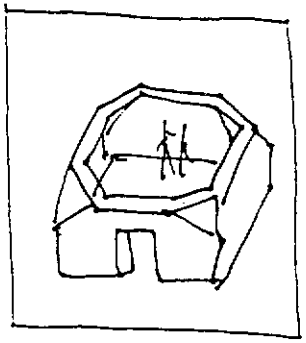
YOU SHOULD PROCEED DIFFERENTLY:



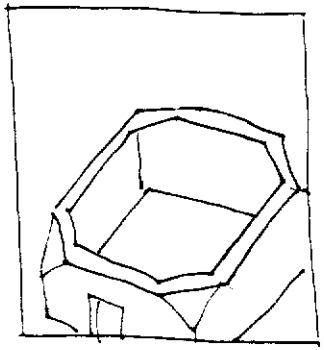
YOU HAVE TO START, IN THE CORNERS, WITH THE PENDENTIVES,



USING FOR THIS PURPOSE THE TECHNIQUE OF VAULTS OR THAT OF FALSE VAULTS.

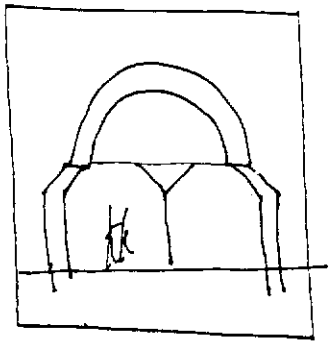


THOSE PENDENTIVES WILL FORM AN OCTOGONAL (OR CIRCULAR) SHOULDER-LINE.

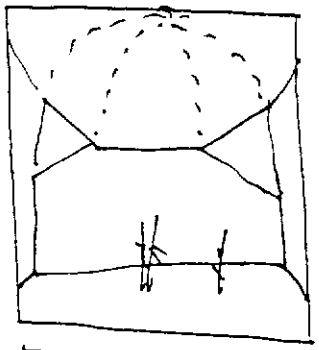


OVER THAT SHOULDER-LINE
YOU CAN BUILD THE DOME.

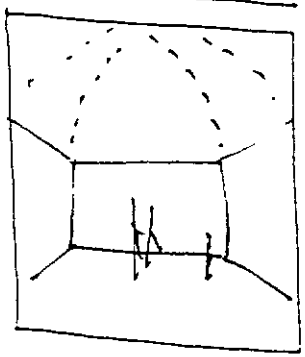
MASONS AND ARCHITECTS
CALL SUCH A DOME A "SUSPENDED" ONE



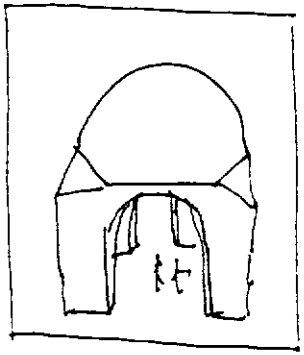
AS IT RESTS ON A SHOULDER
WHICH IS BUILT, PARTLY, OVER A VOID.



A SUSPENDED DOME
MAKES THE ROOM SEEM LARGER

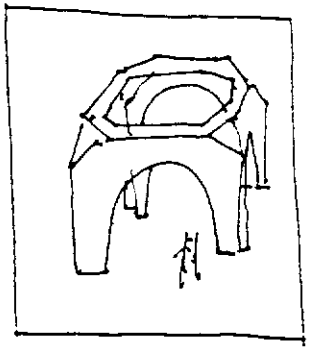


THAN A ROOM
COVERED BY AN ORDINARY DOME
OF THE SAME SIZE.

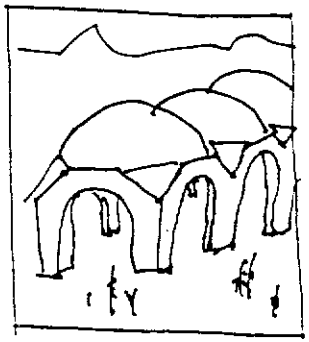


YOU CAN BUILD
A SUSPENDED DOME

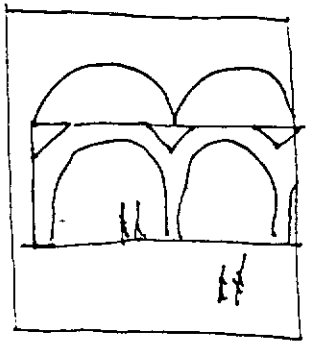
SUPPORTED BY ARCHES ONLY,



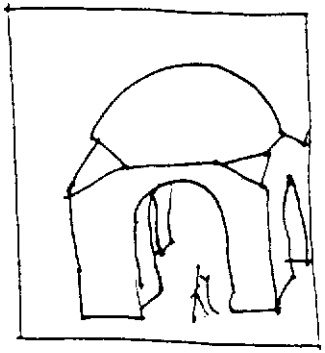
4 ARCHES REPLACING
THE 4 WALLS.



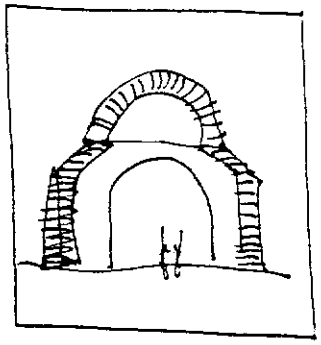
A ROW OF SUCH DOMES
COVERS A LARGE SPACE



WITH NO WALLS,
ONLY A FEW PILLARS.

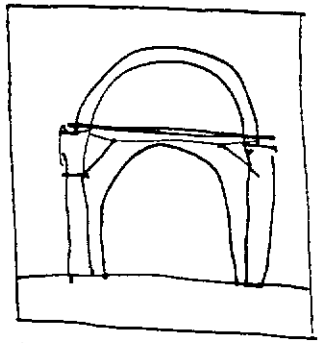


YOU HAVE TO ENSURE
THAT YOU MAKE THE PILLARS MASSIVE

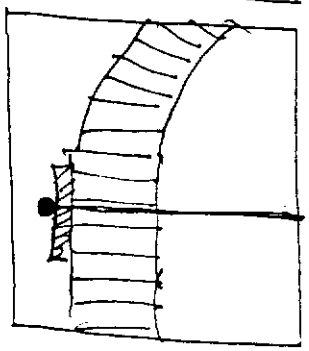


OTHERWISE THE DOME
AND THE PENDENTIVES
EXERCE A SIDE-PRESSURE

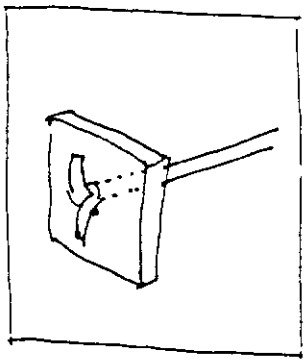
MAKING THE PILLARS FALL.



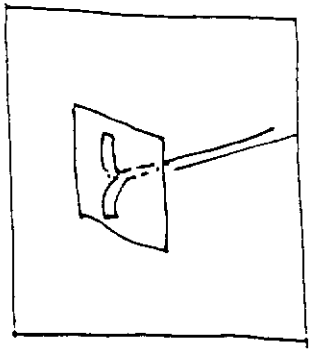
YOU CAN CANCEL THAT SIDE-PRESSURE
WITH IRON RODS
(THE KIND USED IN CONCRETE BEAMS).



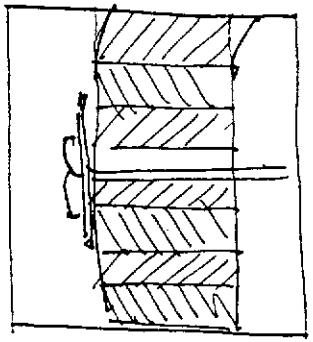
ANCHORED THE RIGHT WAY
SUCH RODS KEEP THE STRUCTURE
TOGETHER.



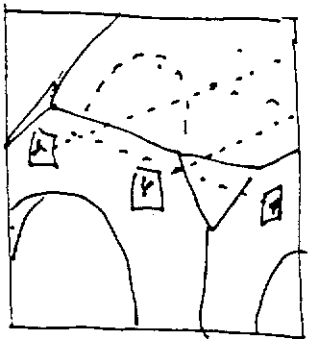
AN APPROPRIATE ANCHOR
CAN BE MADE
WITH A PIECE OF WOOD



OR EVEN WITH SCRAP METAL,



PROVIDED IT HAS A SURFACE
LARGE ENOUGH



SO AS NOT TO TEAR A HOLE
IN THE PILLAR
OR IN THE WALL.

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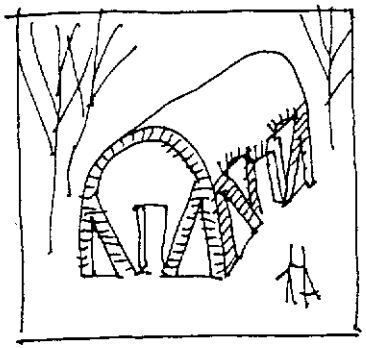
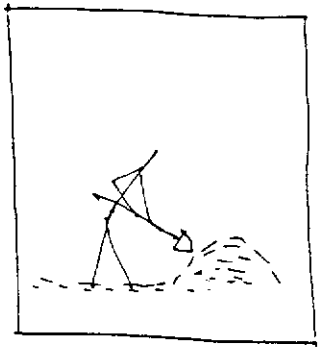
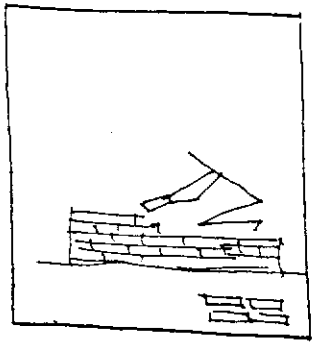
HOW TO KEEP ALOFT
THE ROOF

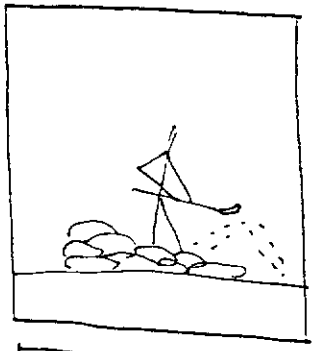




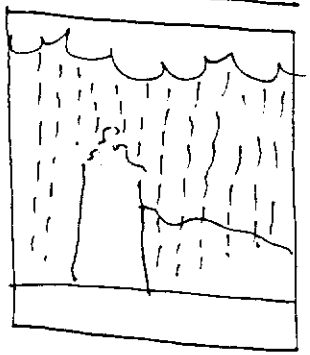
WALLS MADE WITH MUD,



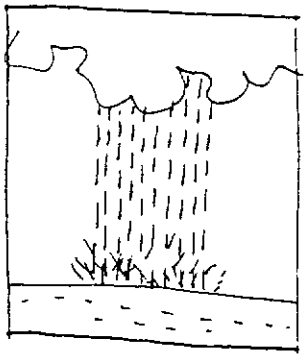
EITHER IN SUN-BAKED BRICKS



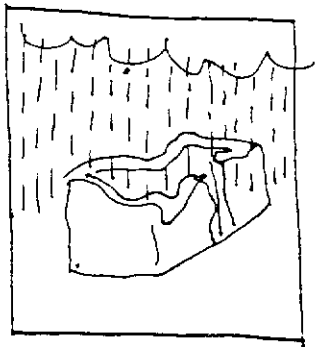
OR IN PISÉ



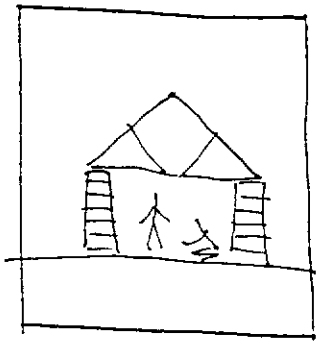
ARE SENSITIVE TO HUMIDITY.



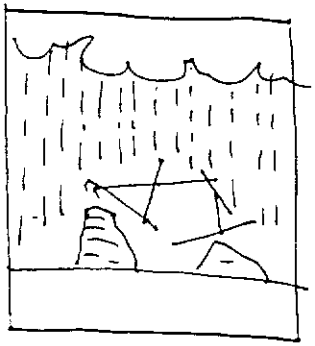
EVEN LITTLE RAIN CAN BE VIOLENT.



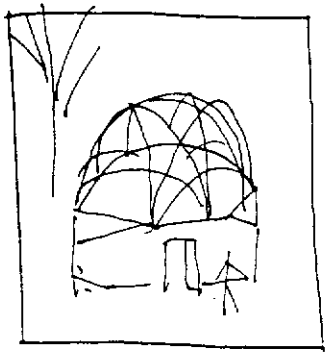
SUCH RAIN DAMAGES SERIOUSLY MUD WALLS.



AND IF THE ROOF IS BORNE BY THE MUD WALLS ALONE

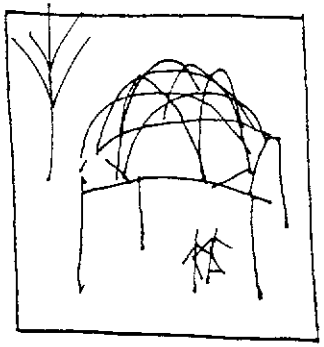


THE WHOLE HOUSE MIGHT COLLAPSE WITH A HEAVY RAINFALL.



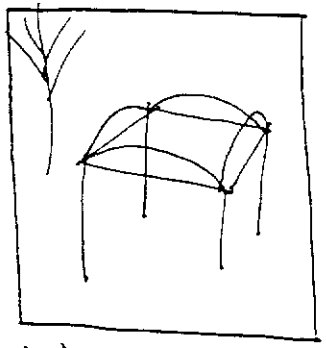
THERE ARE SOLUTIONS
TO PREVENT SUCH DAMAGE.

THE FIRST ONE CONCERNS
ROOFS MADE
WITH VEGETAL MATERIAL.

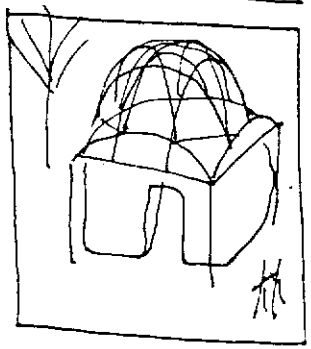


SUCH A ROOF,
WHICH IS USUALLY QUITE LIGHT,

CAN BE BORNE BY POSTS

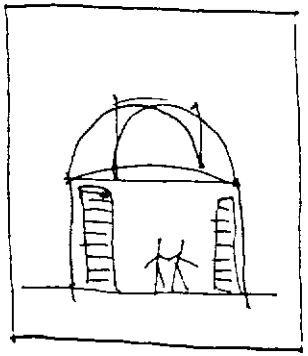


AND A TENSION FRAME.

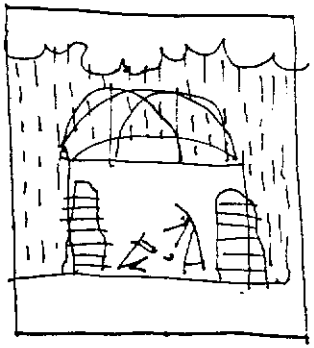


THESE POSTS AND TIERS
SHOULD BE INDEPENDENT

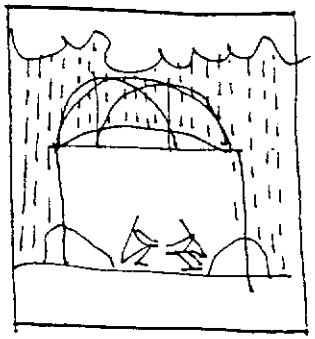
OF THE MUD WALLS.



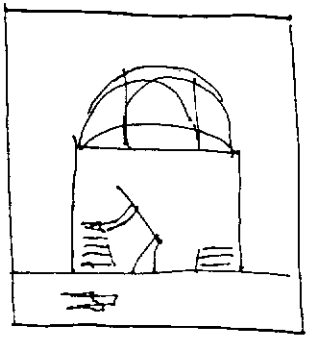
A ROOF
SUPPORTED BY SUCH AN
INDEPENDENT STRUCTURE



WILL KEEP IN PLACE
EVEN IF THE MUD WALL BECOMES SOFT

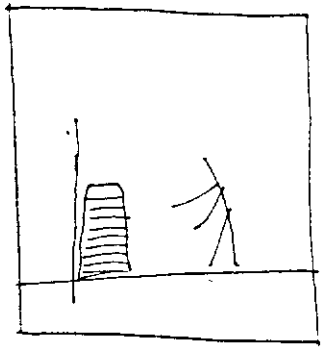


OR IF IT CRUMBLES AWAY.

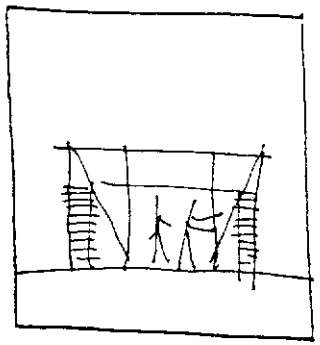


IT IS MUCH EASIER
TO REPAIR A MUD WALL

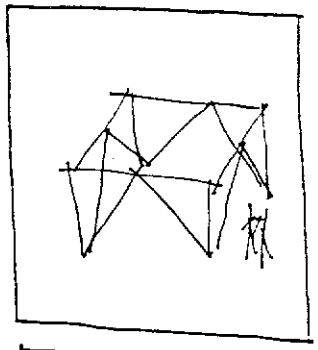
THAN TO REBUILD THE WHOLE ROOF.



A MUD WALL
CAN BE STABILIZED

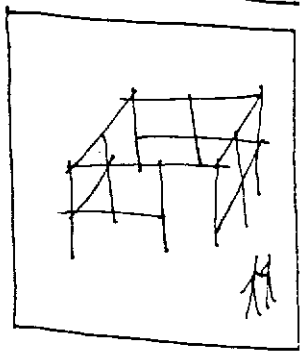


WITH AN INCORPORATED SKELETON
MADE IN BAMBOO OR IN WOOD.

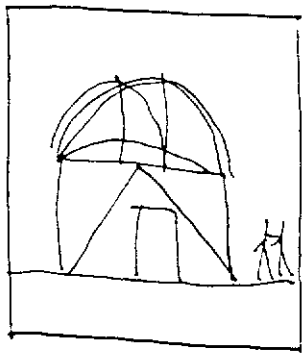


SUCH A SKELETON
IS PARTICULARLY SOLID

WHEN TRIANGULATED

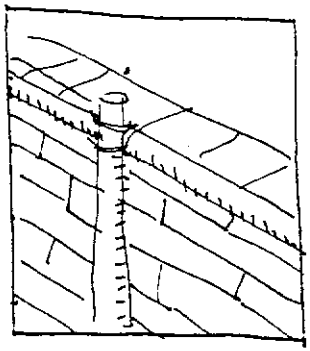


BUT THAT IS NOT ABSOLUTELY
NECESSARY.

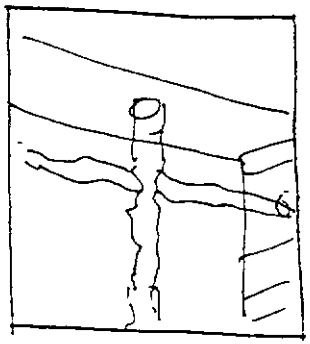


THE RODS MAKING UP
THAT SKELETON

SHOULD BE VISIBLE FROM OUTSIDE,

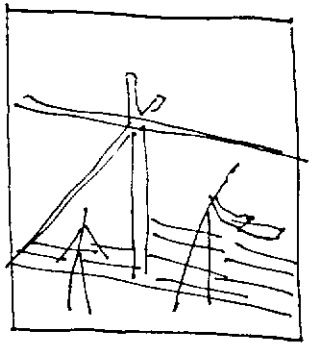


SO THEY WILL GET ENOUGH AIR



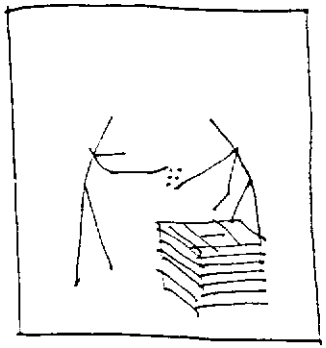
TO AVOID THEIR ROTTING AWAY
FROM HUMIDITY,

WHICH WOULD HAPPEN
IF THEY WERE INSIDE THE WALL.



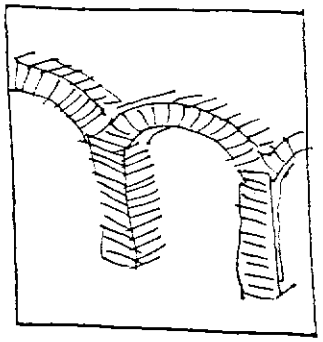
THE MUD CONSTITUTING SUCH WALL
WILL BE FILLED IN

INTO THE MASHES OF THE SKELETON.



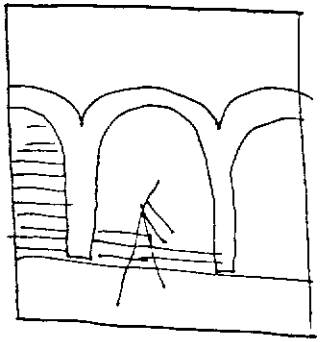
WHERE KILN-BAKED BRICKS ARE AVAILABLE

BUT TOO EXPENSIVE FOR THE ENTIRE WALL TO BE BUILT WITH THEM,

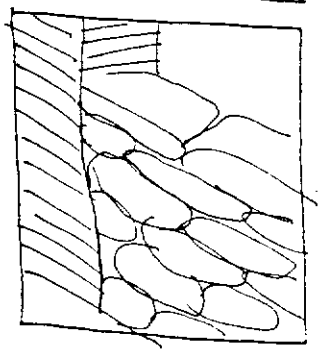


A SKELETON WITH KILN-BAKED BRICKS CAN BE BUILT.

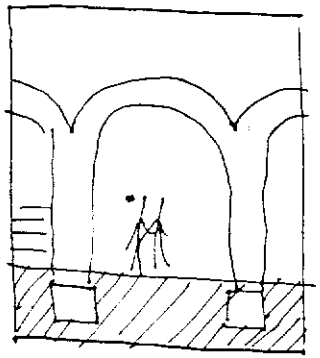
THEN YOU DONT NEED TOO MANY OF THESE EXPENSIVE BRICKS.



THE MESHES OF THAT SKELETON SHOULD BE FILLED

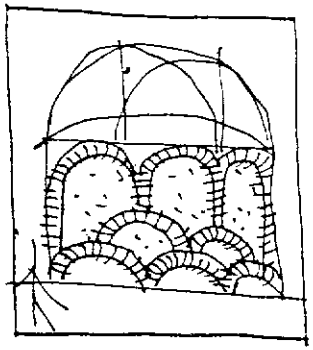


WITH SUN-BAKED BRICKS.



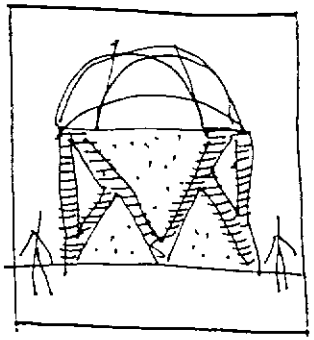
SUCH A SKELETON MADE WITH BRICKS NEEDS SOLID FOUNDATIONS

WHERE IT TOUCHES THE GROUND.

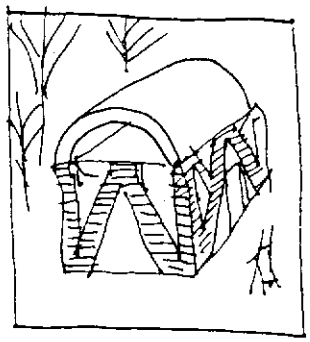


THE SKELETON ITSELF CAN CONSIST

OF A PATTERN OF ARCHS



OR OF FALSE ARCHS.

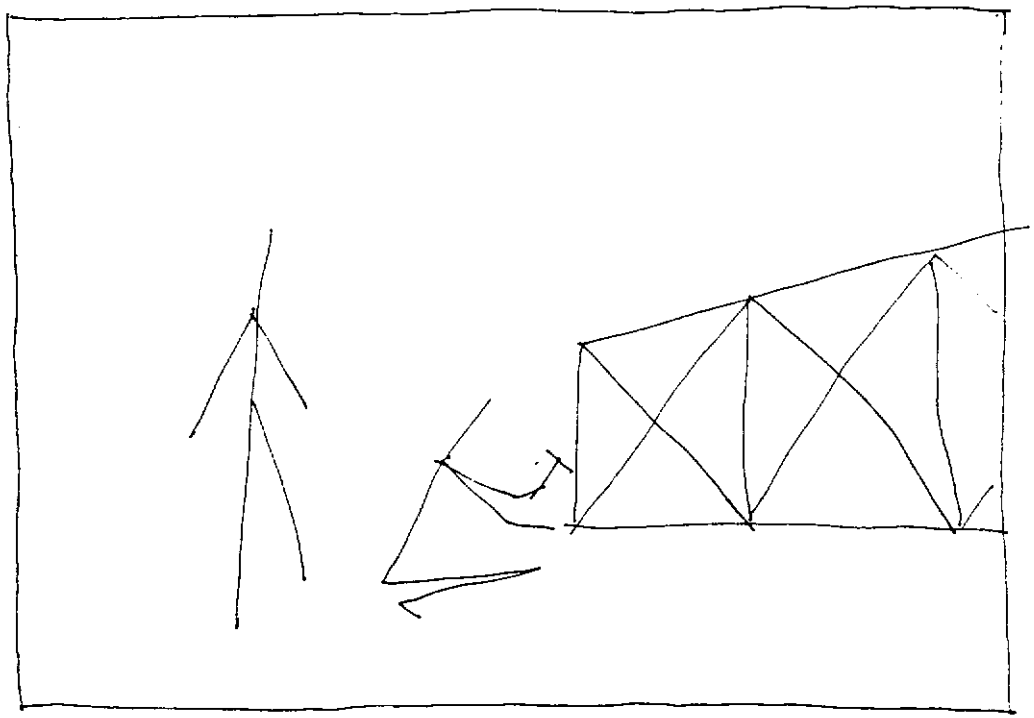


SUCH A SKELETON WILL SUPPORT EVEN A VAULT (WHICH MIGHT BE HEAVY),

WHICH WILL NOT GET DAMAGED WHEN THE MUD OF THE WALL IS WASHE AWAY BY THE RAIN.

COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS



TECHNIQUES TO LEARN

COMMUNICATION CENTRE
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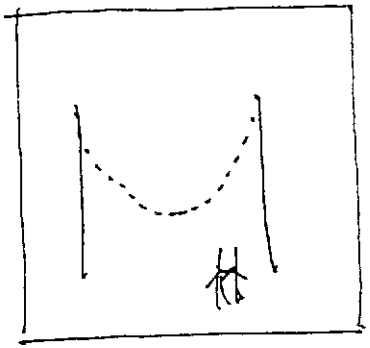
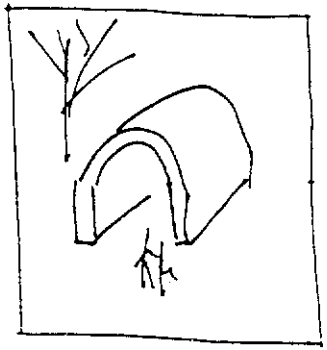
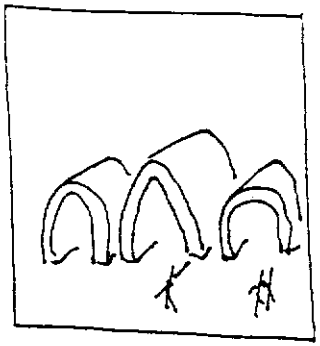
33, BD GARIBALDI, 75015 PARIS ☎ (331) 783-20-24

THE CHAIN-LINE

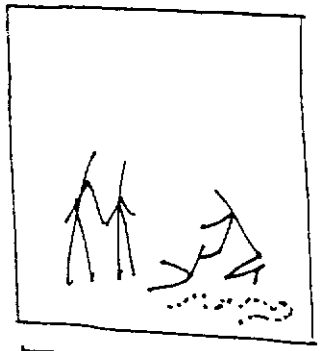




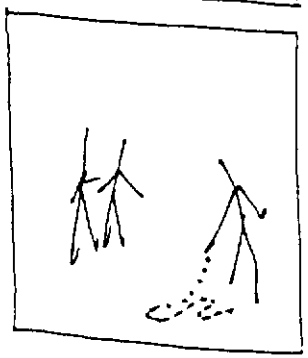
BEFORE BUILDING A VAULT OR A DOME



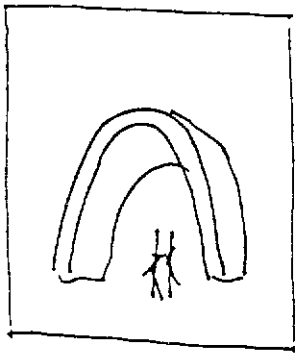
YOU CAN DETERMINE WHICH SHAPE WOULD BE THE MOST ADVANTAGEOUS?



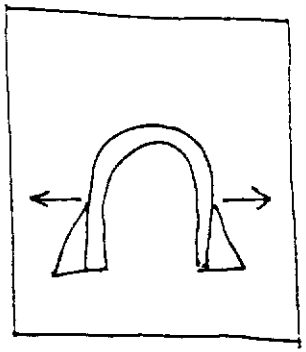
FOR THAT PURPOSE
· THE TECHNIQUE OF THE CHAIN-LINE IS USEFUL,



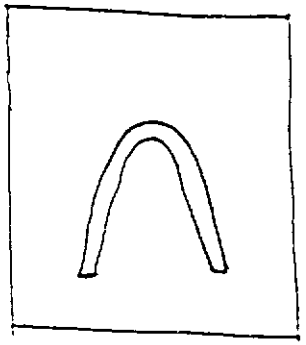
EASY AND EFFICIENT.



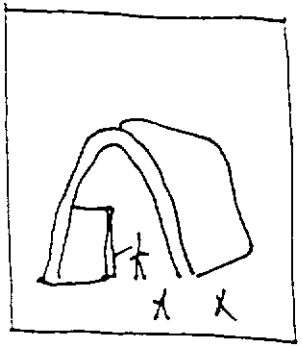
A GOOD SHAPE FOR A VAULT



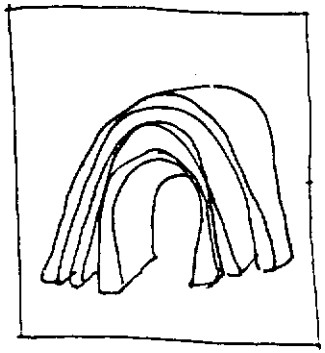
IS ONE WITH THE LEAST SIDE PRESSURE.



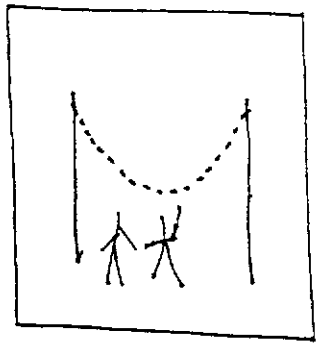
LESS SIDE PRESSURE REQUIRES THINNER . BEARING WALLS,



THINNER,
BUT NOT LESS SAFE .

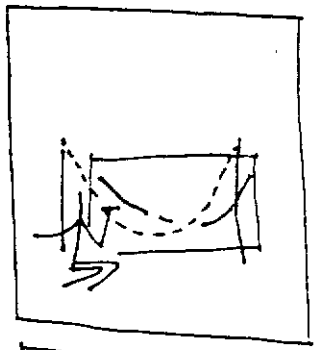


A SHAPE
GENERATING LESS SIDE PRESSURE
CAN BE FOUND

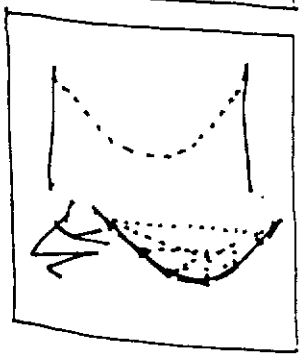


WITH THE HELP
OF A HANGING CHAIN (OR ROPE).

SUCH A CHAIN TAKES,
SPONTANEOUSLY, A PARTICULAR FORM.

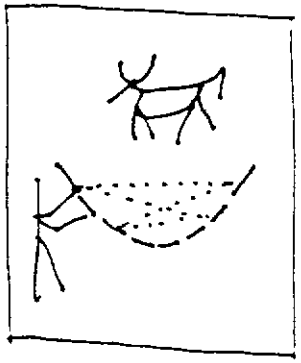


YOU CAN DRAW THIS FORM
ONTO A BOARD,



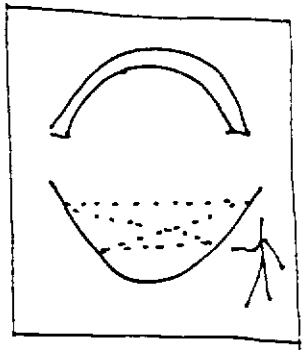
OR YOU CAN BEND A BAMBOO
(OR A REED)
INTO THE SAME SHAPE,

AND FIX IT IN THAT SHAPE
WITH ROPES.

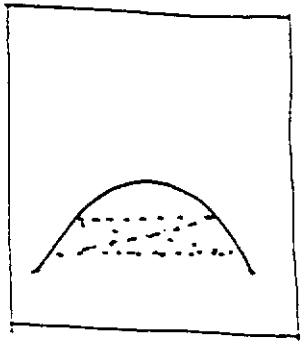


THAT LINE
WHICH YOU HAVE COPIED
FROM THE HANGING CHAIN,

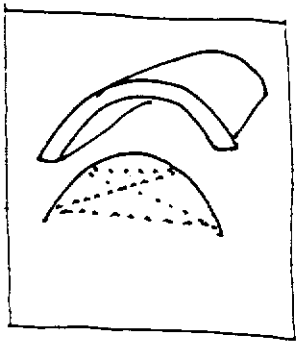
IS, LIKE COWS HORNS,
POINTING UPWARDS.



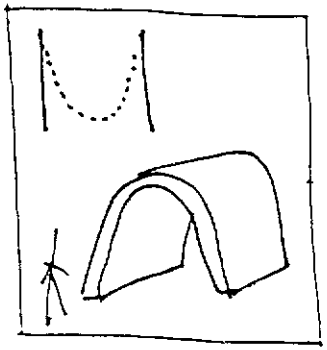
IT IS THE INVERTED SHAPE
OF AN ARCH



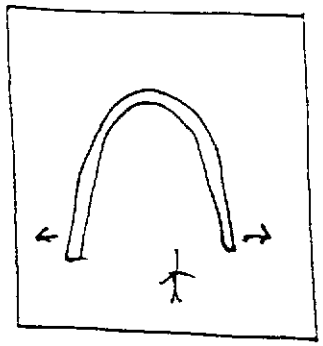
IF YOU PUT THAT MODEL
UPSIDE DOWN,



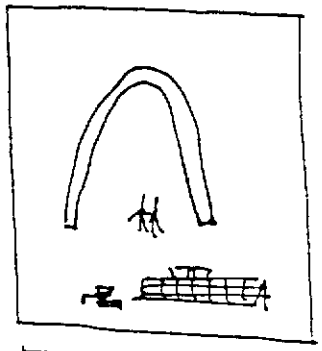
YOU OBTAIN
THE SHAPE OF THE VAULT
YOU WERE LOOKING FOR.



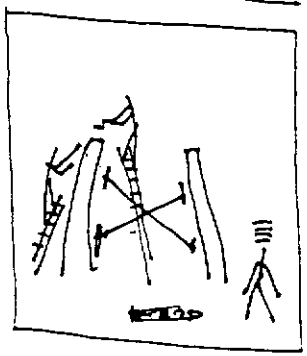
IF YOU MAKE THAT SHAPE HIGHER (BY USING A LONGER CHAIN FOR THE MODEL)



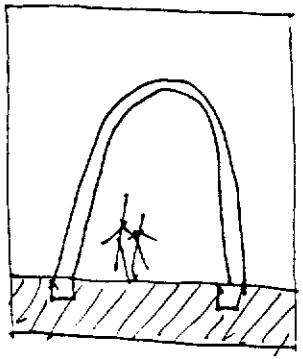
THE SIDE PRESSURE OF THE VAULT WILL BE SMALLER.



BUT, A HIGHER VAULT NEEDS MORE MATERIAL

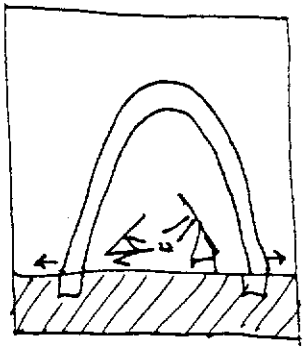


AND MIGHT BE MORE DIFFICULT TO BUILD.

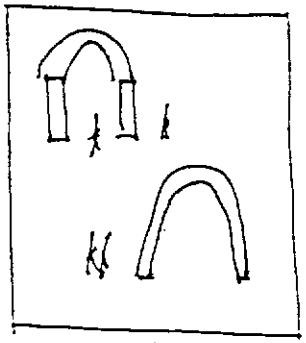


IF YOU START THAT VAULT (OR THAT DOME) DIRECTLY FROM THE GROUND UP

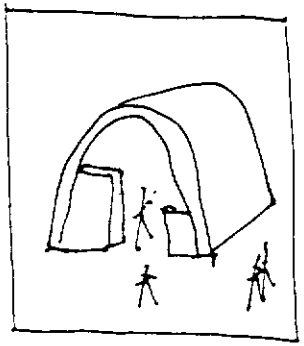
(DIRECTLY ON THE FOUNDATIONS)



YOU HAVE NOT TO BOTHER MUCH ABOUT SIDE PRESSURE,



AND DONT NEED MORE MATERIAL AS IN THE CASE OF A VAULT ON WALLS.



A VAULT ACCORDING A CHAIN-LINE FROM THE GROUND TO THE GROUND

IS A SOLID AND INEXPENSIVE STRUCTURE.

COMMUNICATION CENTRE
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UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
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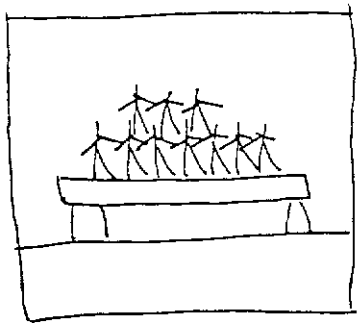
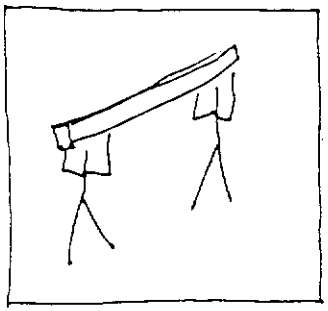
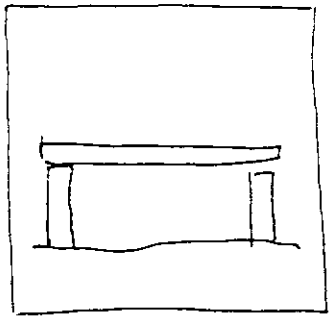
HOW STRONG CAN A BEAM BE ?

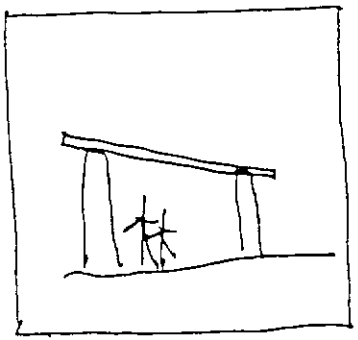




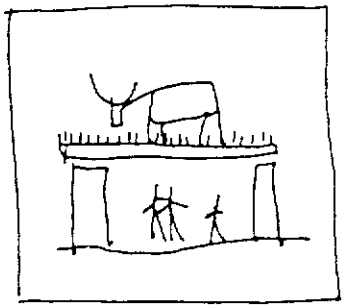
YOU MIGHT SOMETIMES WANT TO SPAN



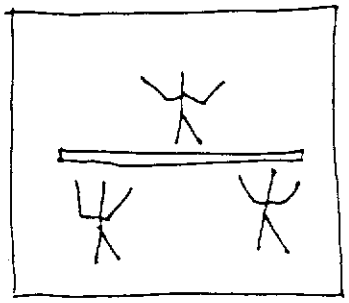
A DISTANCE BETWEEN TWO WALLS OR POSTS WITH A BEAM.



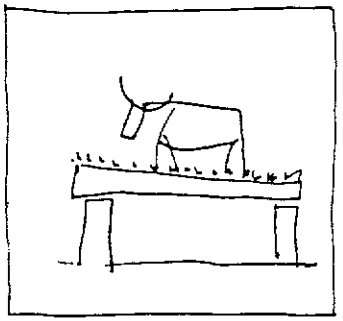
IN ORDER TO SUPPORT A ROOF



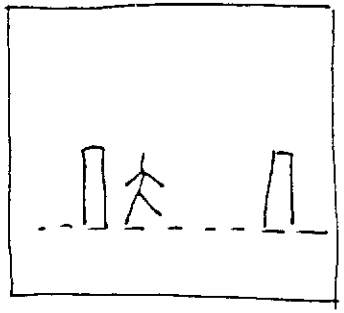
OR OTHER LOADS.



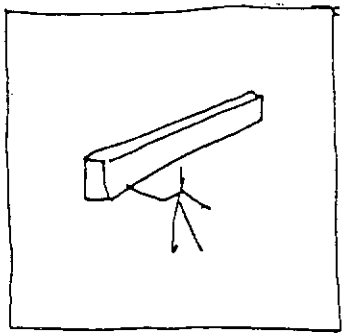
IN ORDER TO SUPPORT LOADS



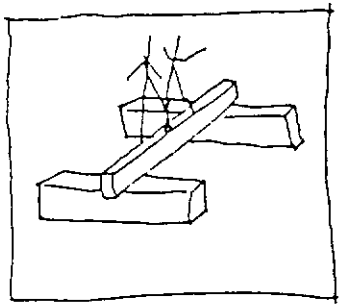
A BEAM HAS TO BE STRONG.



HOW STRONG IT IS WILL DEPEND UPON THE SPAN (THE DISTANCE BETWEEN THE SUPPORTS)

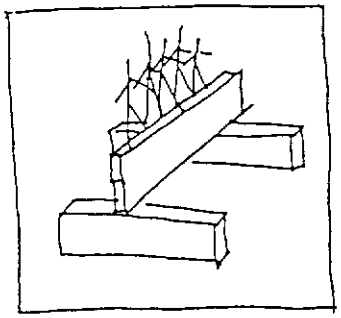


AND ON THE PROPORTIONS OF THE BEAM ITSELF.

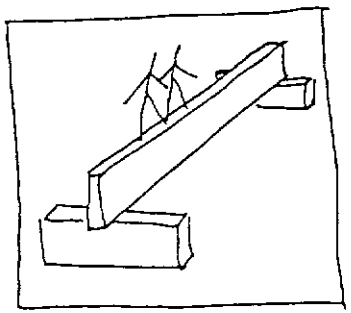


IF A BEAM BEARS A LOAD
OVER A SPAN

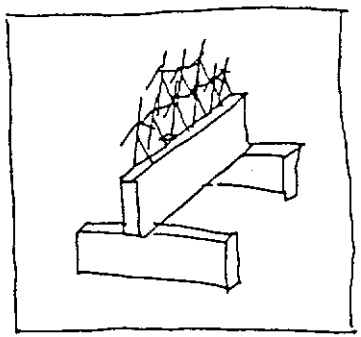
AND THAT BEAM
HAS A CERTAIN HEIGHT



A BEAM TWICE AS HIGH
BEARING THE SAME LOAD

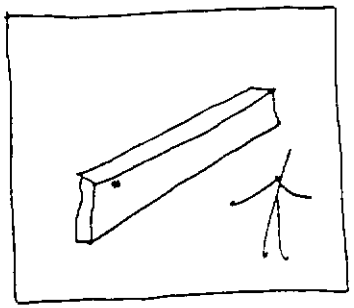


CAN SPAN A DISTANCE
TWICE AS WIDE,



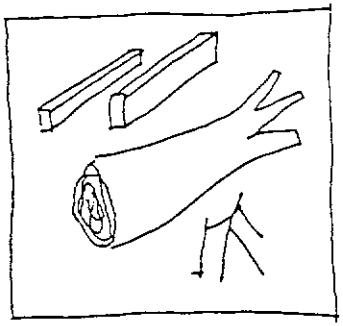
OR IT CAN BEAR
OVER THE ORIGINAL SPAN

FOUR TIMES AS MUCH LOAD.



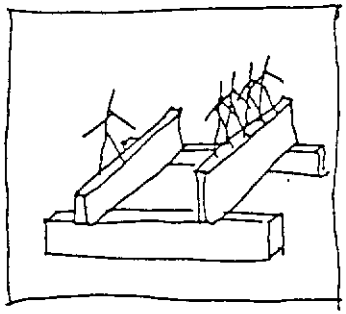
THE STRENGTH OF A BEAM

DEPEND THUS



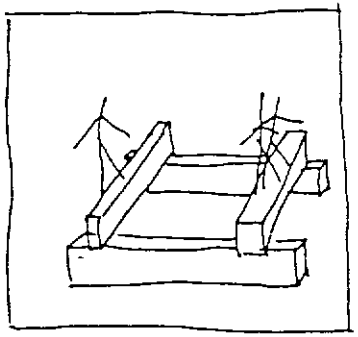
① ON THE MATERIAL
IT IS MADE OF,

(A METAL BEAM IS STRONGER
THAN A BEAM IN HARDWOOD,
A HARDWOOD BEAM IS STRONGER
THAN ONE MADE OF SOFT WOOD,
ETC).



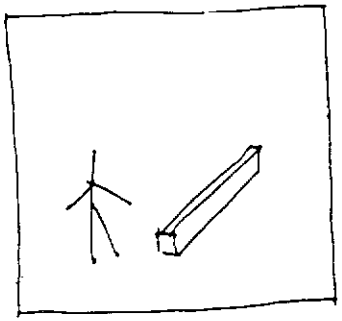
② ON ITS HEIGHT

(A BEAM TWICE AS HIGH
CAN BEAR 4 TIMES MORE LOAD,
3 TIMES AS HIGH
9 TIMES MORE LOAD
ETC).

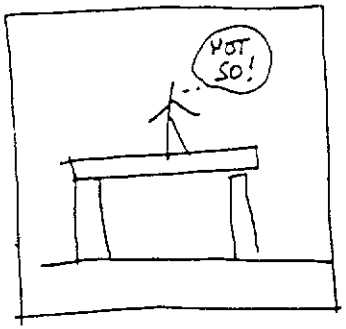


③ AND ON ITS BREADTH

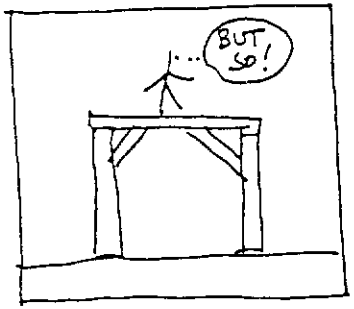
(A BEAM TWICE AS BROAD
BEARS TWICE MORE LOAD,
3 TIMES BROADER
3 TIMES MORE LOAD
ETC).



YOU CAN INCREASE
THE STRENGTH OF A BEAM

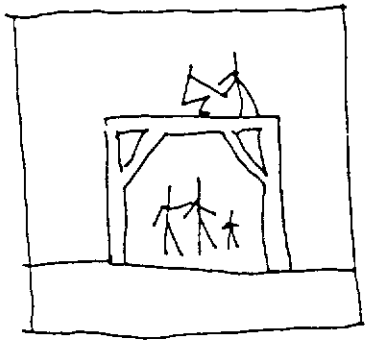


IF, INSTEAD OF POSING IT SIMPLY
ON ITS SUPPORTS
(WALLS OR POSTS).



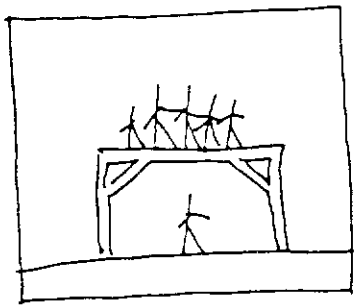
YOU FIX IT TIGHTLY
TO THOSE SUPPORTS

(FOR EXAMPLE,
WITH TWO BOARDS DISPOSED IN DIAGONAL).

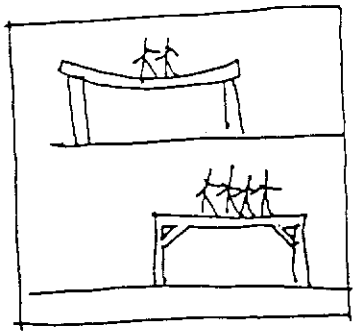


THEN BEAM AND SUPPORT TOGETHER
WILL FORM ONE WHOLE
AND WILL WORK TOGETHER.

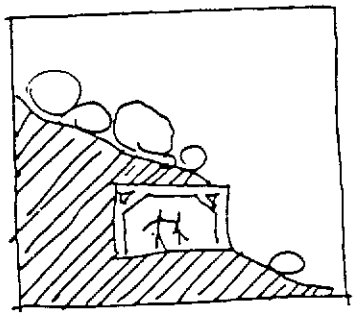
SUCH A CONSTRUCTION
WE CALL A "FRAME".



FRAMES
ARE VERY STRONG.

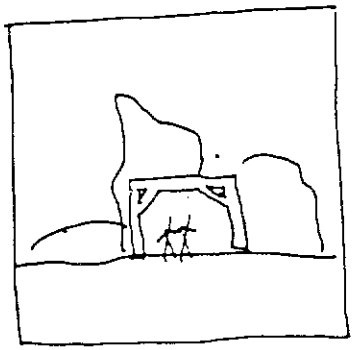


THEY CAN BEAR SOMEWHAT MORE
WEIGHT
THAN BEARS A SIMPLE BEAM.



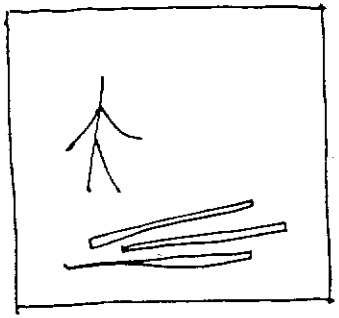
THEY GIVE SECURITY
IN SUCH CASES
WHERE A BEAM POSED ON THE SUPPORTS
WOULD BREAK

OR THE SUPPORTS COLLAPSE.



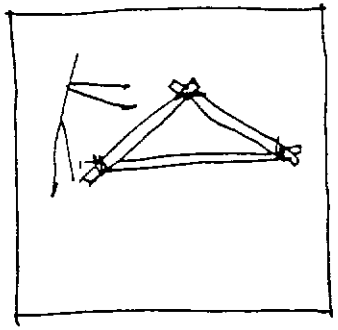
FOR EXAMPLE,
IN CASE OF EARTHQUAKE

A FRAME CAN BE QUITE SAFE.

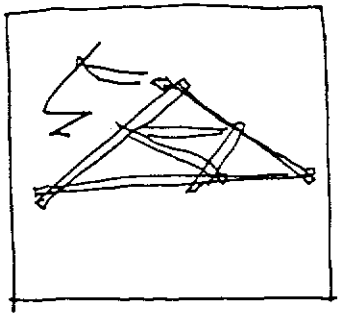


ANOTHER WAY OF INCREASING THE STRENGTH OF A BEAM

(WHEN YOU WANT TO USE AS LITTLE WOOD AS POSSIBLE)

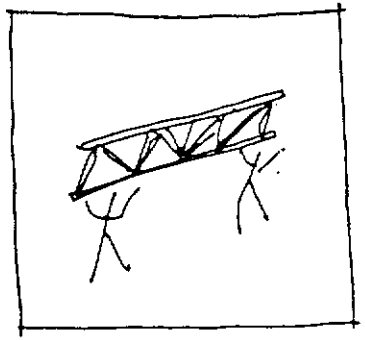


IS TO "TRIANGULATE" THE BEAM: BY GIVING TO IT THE FORM OF ONE TRIANGLE



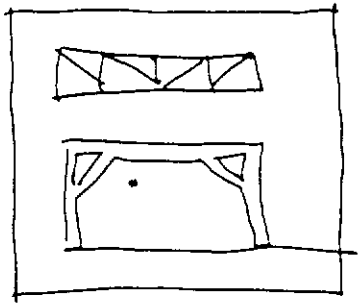
OR MORE.

A TRIANGULATED BEAM CAN BE MADE OF THIN WOOD AND BE STRONG AT THE SAME TIME.

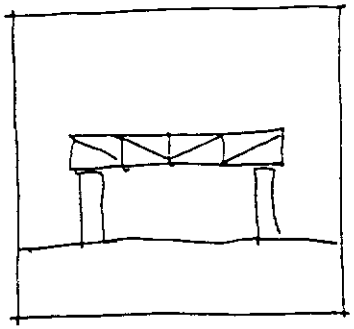


A GRID LIKE BEAM USES VERY LITTLE WOOD

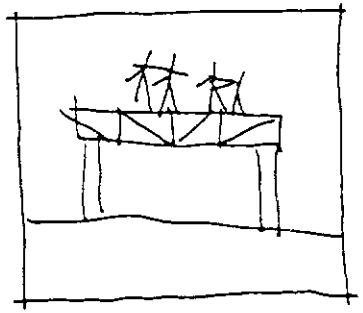
AND STAYS VERY STRONG.



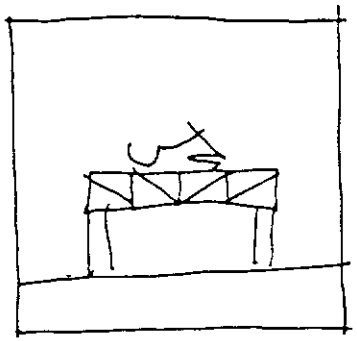
WHEN YOU MAKE A FRAME OR A TRIANGULATED BEAM,



TEST IT BEFORE ADOPTING IT OVER THE SPAN YOU PLAN TO BRIDGE OVER.



TEST IT WITH A LOAD SUPERIOR TO WHAT IT WILL BEAR ONCE IN USE:



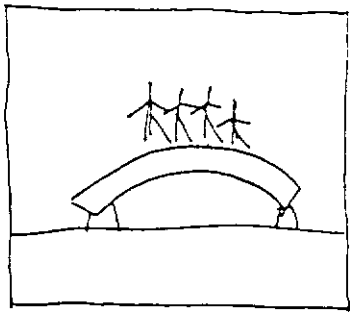
IF THE FRAME CAN BEAR THE LARGER LOAD,

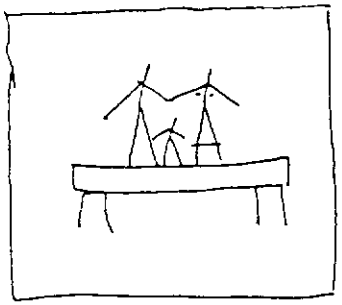
IT WILL BEAR THE DEFINITIVE ONE WITHOUT ANY RISK.

COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

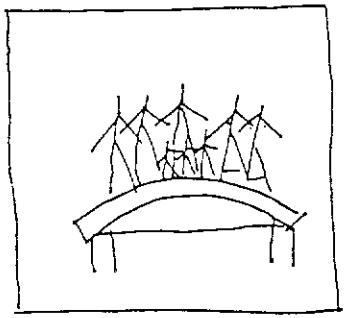
UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

BENDING
MAKES THE BEAM STRONGER

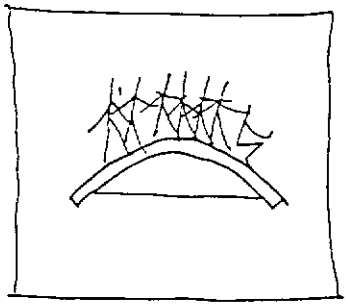




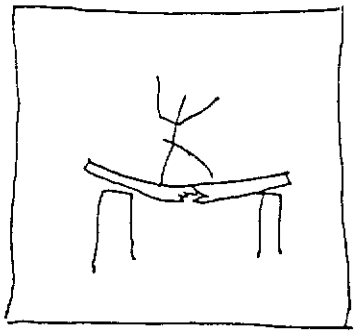
THE STRENGTH OF A BEAM CAN BE INCREASED



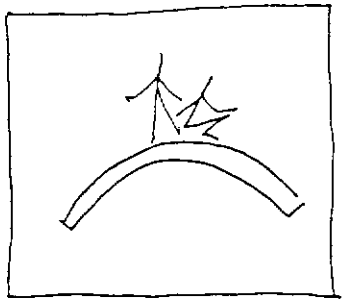
WHEN THE BEAM IS BENT THE RIGHT WAY.



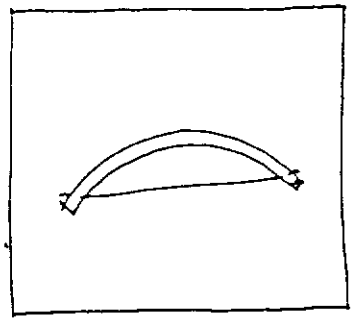
BENDING UPWARDS MAKES THE BEAM STRONGER,



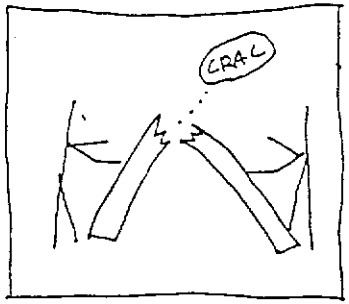
BENDING DOWNWARDS CAN REDUCE ITS STRENGTH.



A BENT BEAM CAN BEAR MORE WEIGHT

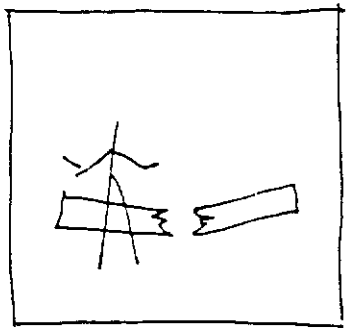


WHEN IT IS BENT, SIMILAR TO AN ARC (A BOW)

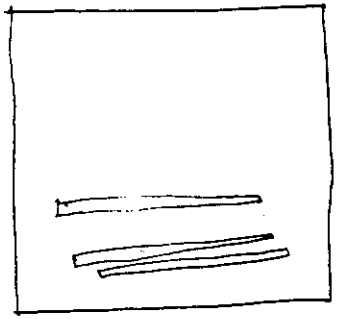


BUT, ONE HAS TO TAKE CARE NOT TO OVERBEND IT,

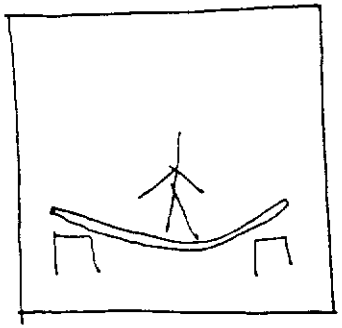
AS A BENT BEAM IS MADE OF A PIECE OF THIN WOOD (YOU CANNOT BEND THICK WOOD EASILY),



AND THAT THIN PIECE OF WOOD MIGHT CRACK IF OVERBENT.

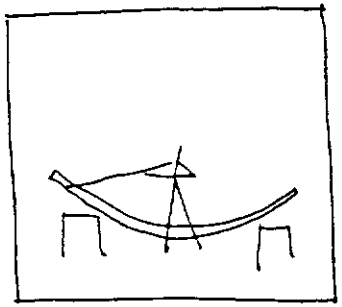


THIN STICKS ARE IDEAL FOR A BENT BEAM.



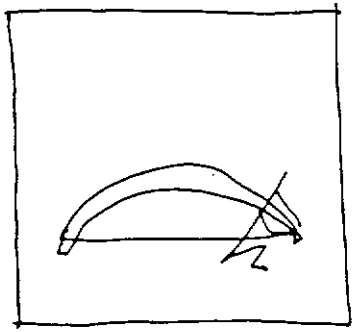
YOU CAN BEND THEM UNDER YOUR OWN WEIGHT

(BUT TAKE CARE NOT TO BREAKE ~~THEM~~).



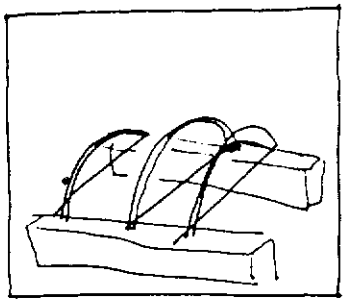
WHEN THE WOOD IS PROPERLY BENT

YOU SHOULD FASTEN ITS ENDS TOGETHER

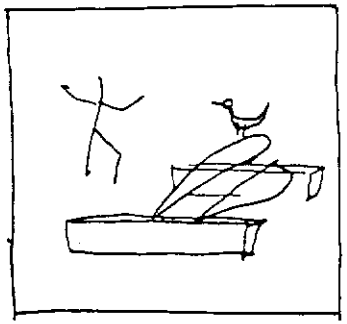


WITH A STRING OR A ROPE.

SUCH A BENT BEAM WILL LOOK SIMILAR TO A BOW.

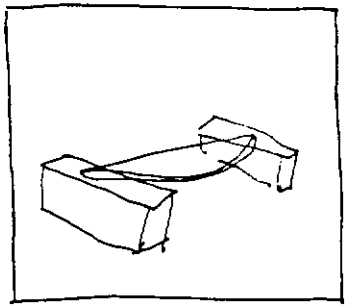


IF YOU WANT SUCH BENT BEAMS TO SUPPORT YOUR ROOF,

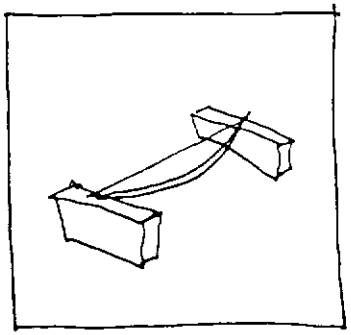


YOU SHOULD TAKE CARE THAT THE BENT BEAMS DONT BUCKLE (LEAN) TO THE SIDE

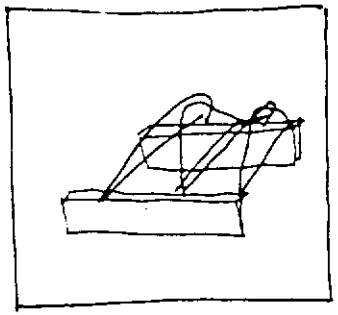
ONCE THE LOAD IS CHARGED ON THEM.



A BENT BEAM LEANING TO THE SIDE HAS NO BEARING STRENGTH AT ALL,

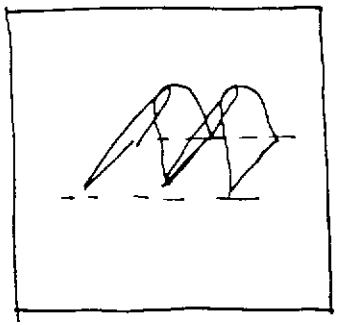


NEITHER DOES A BENT BEAM TURNING DOWN.

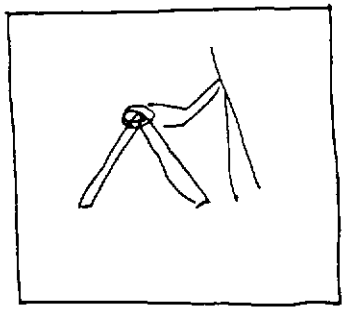


IN ORDER TO AVOID
BENT BEAMS LEANING ASIDE
COMPLETELY

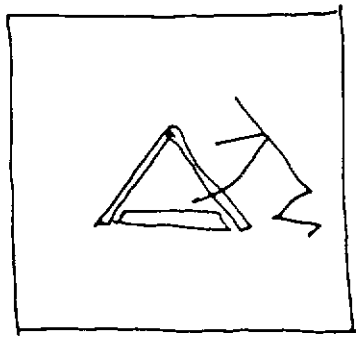
YOU CAN TIE THEM
TOGETHER IN PAIRS,



EACH OF THE TWO BEAMS
LEANING SLIGHTLY
AWAY FROM EACH OTHER.

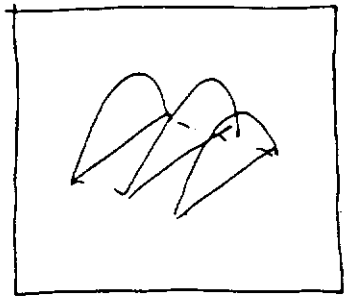


YOU SHOULD THEN
TIE THEIR UPPER BOARDS TOGETHER
WITH A ROPE

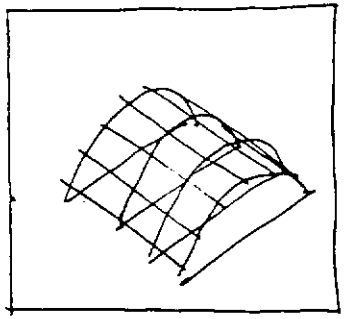


AND KEEP
THEIR LOWER ENDS APART
BY TWO SMALL PIECES OF WOOD.

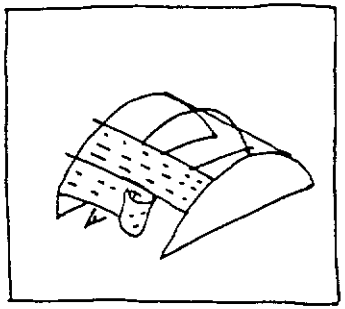
SUCH A COMPOSED BEAM
CAN BE QUITE STRONG.



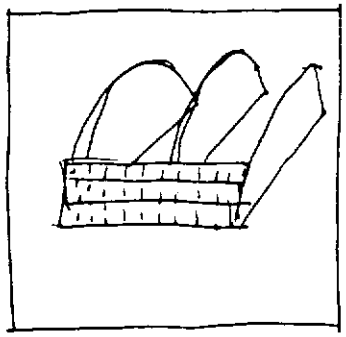
YOU CAN FIX TOGETHER
A ROW OF BENT BEAMS
AS WELL



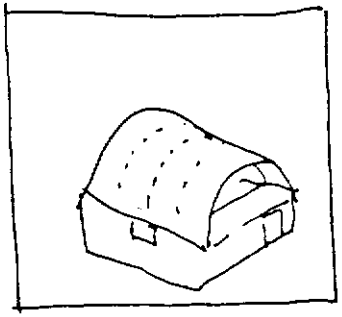
WITH THIN PIECES OF WOOD



OR WITH LONG MATS.

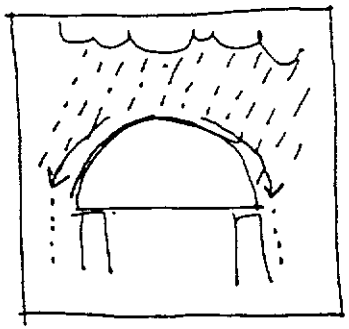


ONLY BE CAREFUL
THAT THE MAIN CANES OF THE MAT
SHOULD LIE
CROSSWISE TO THE BEAMS.

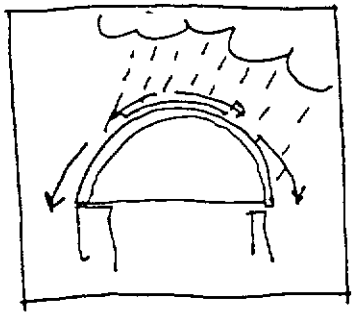


BENT BEAMS ARE GOOD SUPPORT FOR ROOFS

BECAUSE THEIR FORM ASSURES A GOOD SLOPE

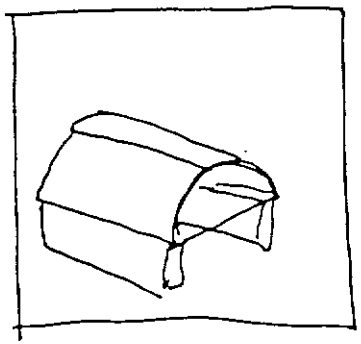


A SLOPE NECESSARY TO ALLOW WATER RUN-OFF.



ONLY THE UPPERMOST PART OF THE ROOF STAYS FLAT

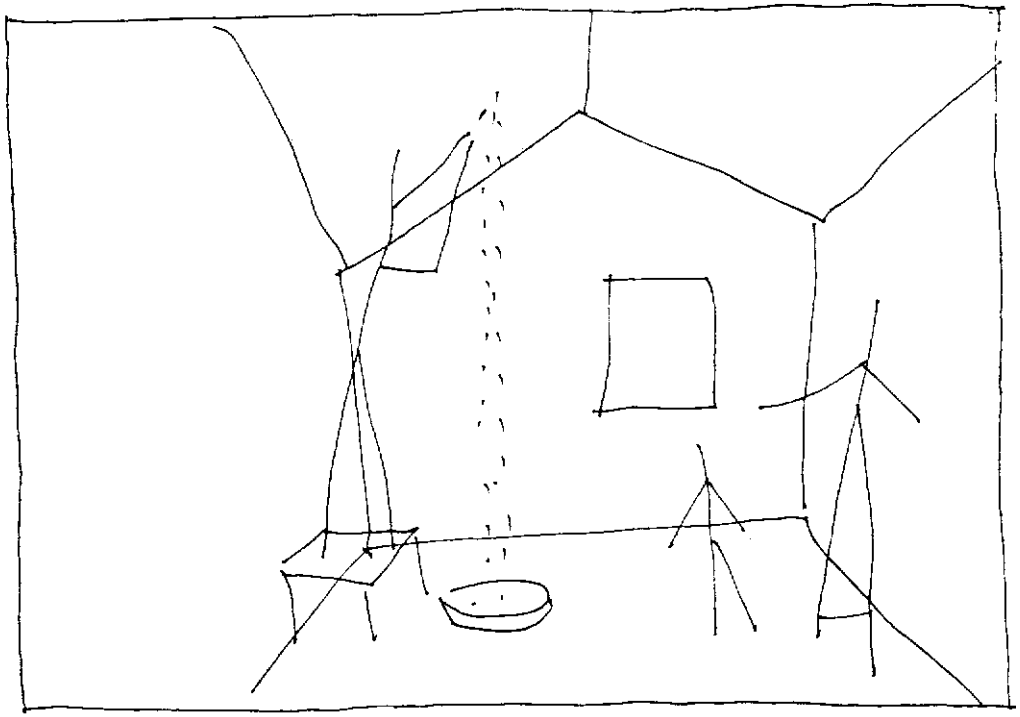
(BECAUSE OF THE BOW SHAPE OF THE BEAM).



THERE YOU SHOULD USE A PARTICULARLY WATERTIGHT COVER MATERIAL.

COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

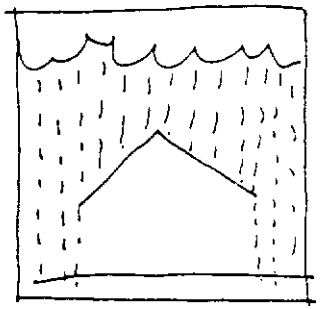


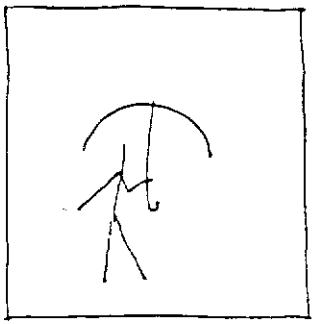
PRACTICAL THINGS ABOUT ROOFS

COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

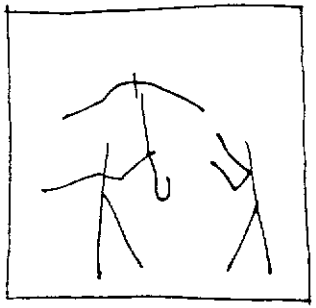
A ROOF SHOULD RESIST
TO WATER



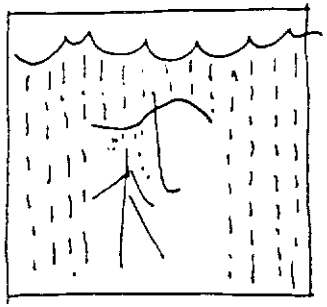


A ROOF
PROTECTS YOU

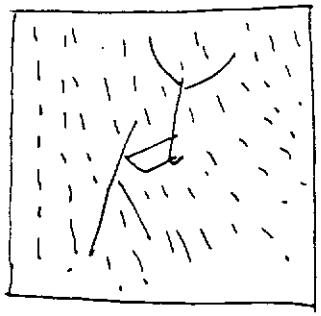
AGAINST THE WEATHER.



BUT A ROOF HAS TO BE
WELL MADE,

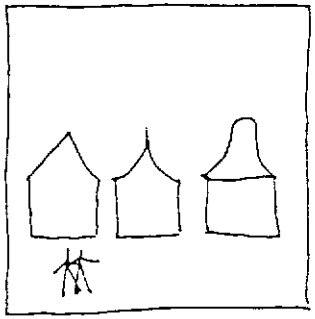


OTHERWISE IT COULD LEAK
WHEN IT RAINS,



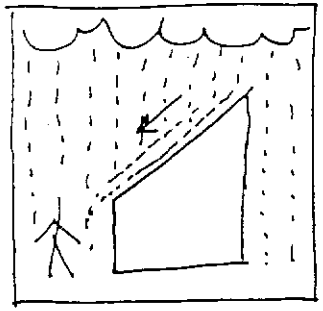
OR, IT COULD LET THROUGH
MUCH WATER.

IF THE RAIN IS ACCOMPANIED BY WIND:
THEN THE WIND BLOWS THE WATER IN.

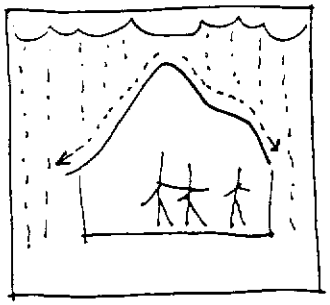


THE FIRST THING YOU CAN DO
TO MAKE YOUR ROOF WATERPROOF

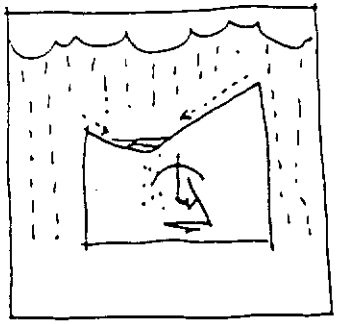
IS TO CHOOSE AN APPROPRIATE SHAPE FOR



WATER ALWAYS TENDS TO RUN
DOWNWARDS, ON A SLOPE,

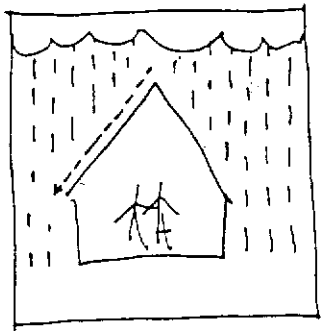


SO A GOOD ROOFSHAPE
HAS TO HAVE SUFFICIENT SLOPE
FOR THE RAINWATER
TO RUN DOWNWARDS,

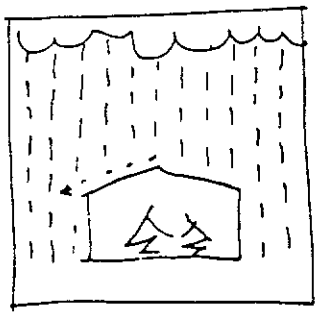


WITHOUT ACCUMULATING IN SOME SPOTS
FORMING SMALL POOLS.

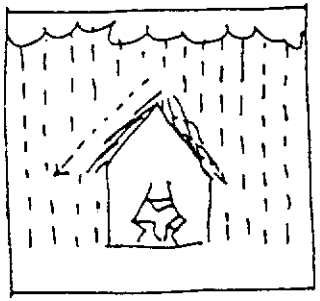
A ROOF ON WHICH WATER ACCUMULATES
LEAKS ALMOST IN EVERY CASE.



IF YOUR ROOF HAS STEEP SLOPES,

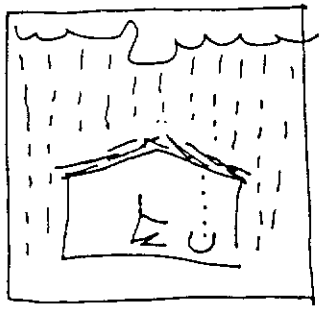


THE WATER WILL RUN OFF FASTER THAN ON GENTLE SLOPES.



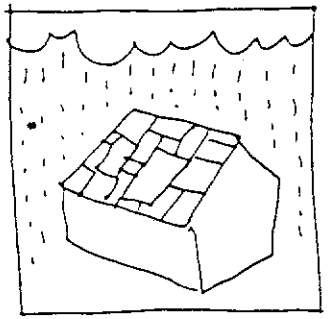
IF THE WATER RUNS FAST, THE ROOF WILL NOT LEAK

EVEN IF IT WAS MADE OF LESS WATERPROOF MATERIALS.

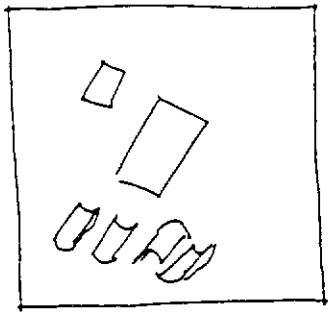


IF THE SLOPE IS SMALL, WATER TRICKLES DOWN SLOWLY.

AND IT MIGHT GET INTO CRACKS AND JOINTS: THEN THE ROOF WILL LEAK, IF MADE WITH LESS WATERPROOF MATERIALS.

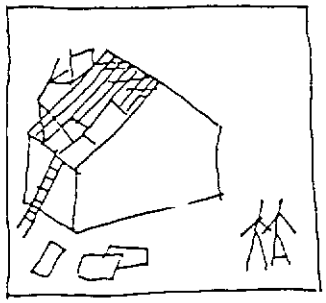


THE WATERPROOF COVER OF A ROOF CAN BE MADE WITH TILES, WITH PLATES, MATS OR SIMILAR STUFF,



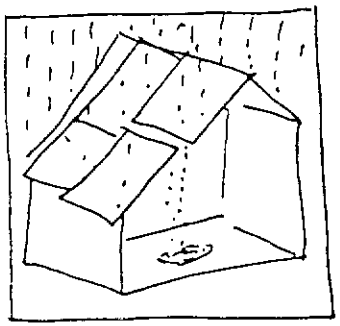
IN VARIOUS SHAPES AND SIZES.

(FOR EXAMPLE, TILES ARE SMALL SHEETS HAVING A SPECIAL FORM).

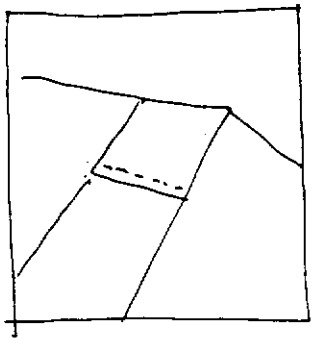


SUCH SHEETS HAVE TO BE DISPOSED IN A CERTAIN WAY

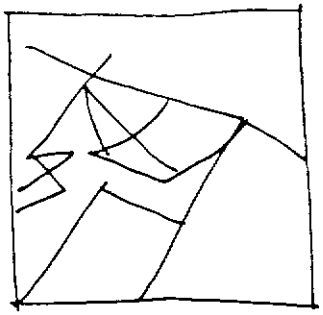
ON THE SUPPORTING STRUCTURE.



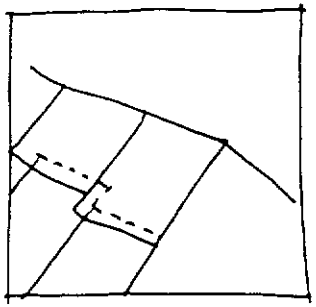
IN ORDER TO PREVENT LEAKING IN WHERE TWO NEIGHBOURING SHEETS ARE JOINED TOGETHER.



THE UPPER ROW OF SUCH SHEETS
HAS TO COVER WITH ITS LOWER EDGE

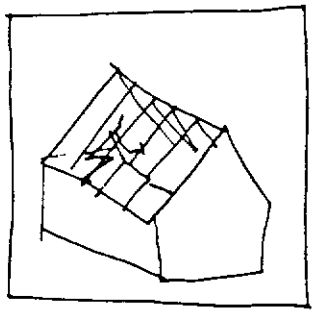


THE UPPER EDGE
OF THE FOLLOWING ROW;



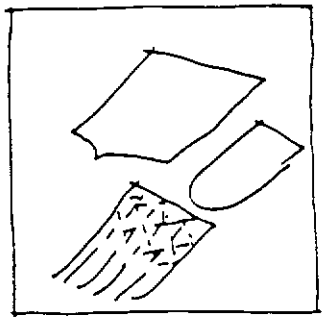
THE UPPER EDGE OF EACH ROW
HAS TO BE COVERED

BY THE LOWER EDGE
OF THE ROW IMMEDIATELY ABOVE IT.



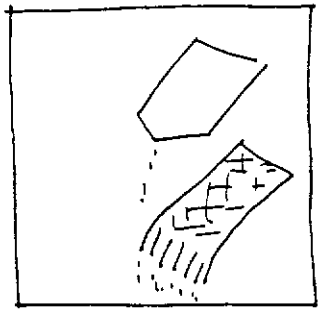
THUS, YOU HAVE TO START TO WORK,
WHEN COVERING A ROOF,
WITH THE LOWEST ROW,

AND CONTINUE IT ROW BY ROW
UPWARDS.

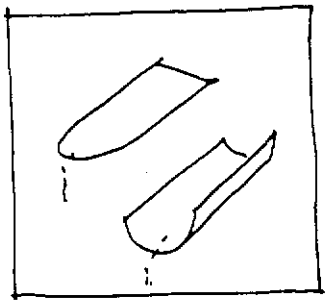


THE SHEETS THEMSELVES
SHOULD BE CUT
(OR TRESSED)

IN SUCH A WAY

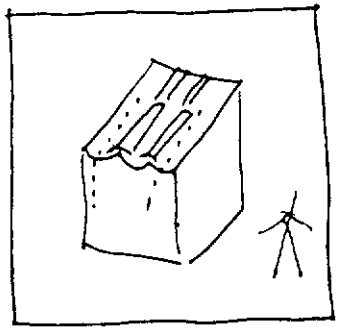


AS TO HAVE ONE OR MORE
"DRIP-NOSES"



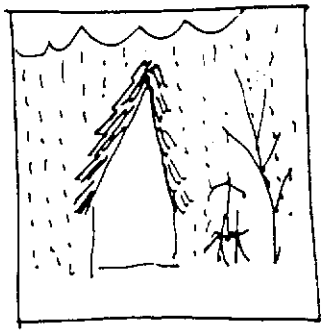
THAT IS, POINTS,
OR THREADS POINTING DOWN,

OR SMALL CANALS,

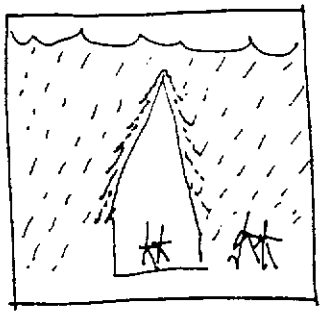


WHICH WILL MAKE THE WATER
TAKE A PARTICULAR PATH

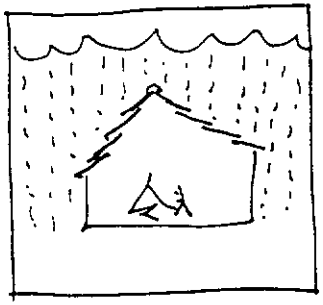
WHEN RUNNING DOWN THE ROOF.



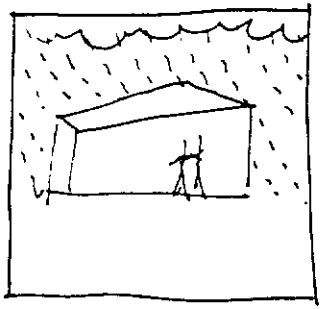
A STEEP ROOF
COVERED WITH THATCH,



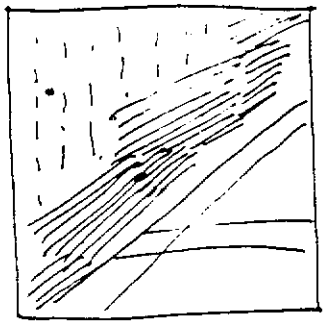
OR WITH SMALL PRESSED MATS



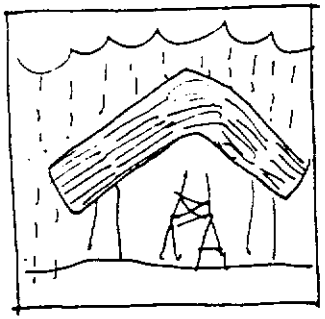
PROTECTS THE INTERIOR OF THE HOUSE
AS WELL AS EXPENSIVE TILES DO



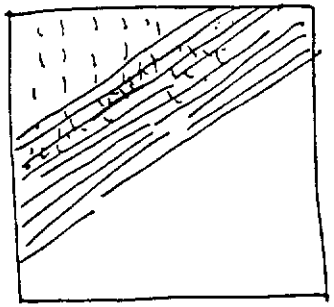
OR AS AN ASPHALT SHEAR
ON A FLAT ROOF DOES.



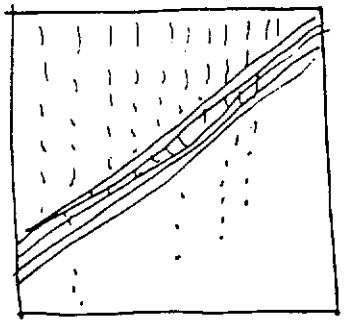
THE THICKNESS OF THE WATERPROOF COVER



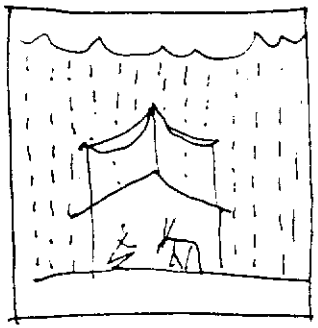
PLAYS AN IMPORTANT ROLE
IN THE RESISTANCE TO LEAKAGE:



A THICK THATCH ROOF,
FOR EXAMPLE,
IS MORE WATERPROOF

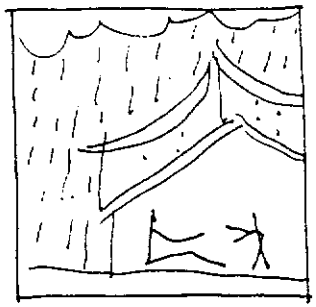


THAN A THIN ONE.

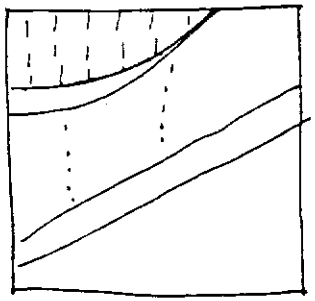


OFTEN
DOUBLING THE ROOF COVER

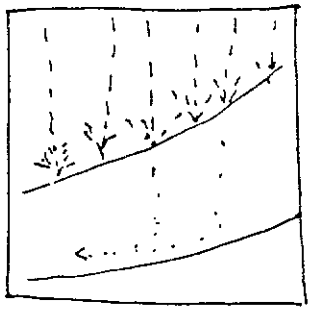
HAS ITS ADVANTAGES.



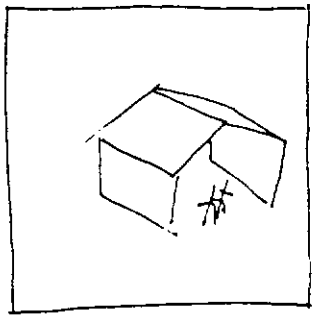
THEN THE UPPER ROOF
DEVIATES THE LARGEST PART
OF RAINWATER



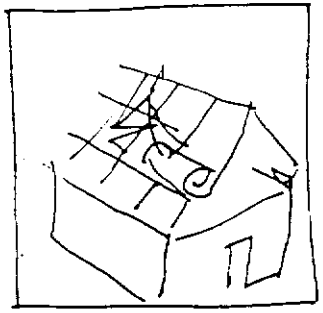
AND THE LOWER COVER
PROTECTS THE INTERIOR WELL
AGINST THE REST OF THE WATER



WHICH DOES NOT HAVE
THE HEAVY IMPACT OF FALLING RAIN.

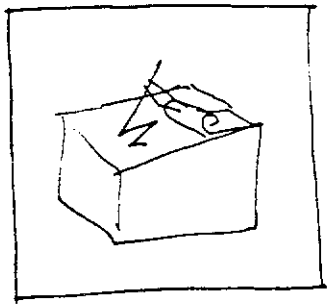


A ROOF CAN BE MADE WATERPROOF

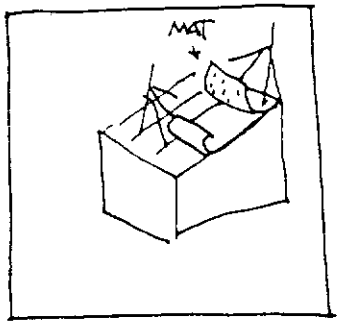


SIMPLY WITH PLASTIC FOILS,

WITH A LAYER OF ASPHALT OR TAR
AND SIMILAR MATERIALS,

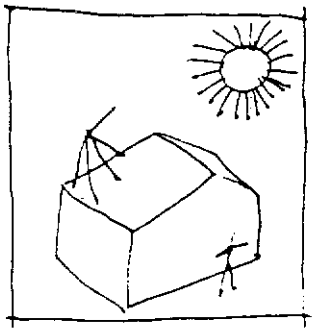


PARTICULARLY ON ROOFS
WHICH ARE NEARLY FLAT.

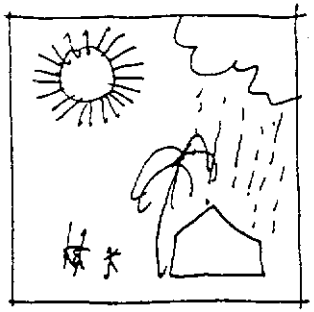


BUT PLASTIC FOIL, ASPHALT OR TAR
SHOULD BE PROTECTED
AGAINST WIND
AND DIRECT SUNSHINE.

ROUGH WEATHER CAN DETERIORATE TH
IF THEY ARE NOT PROTECTED.

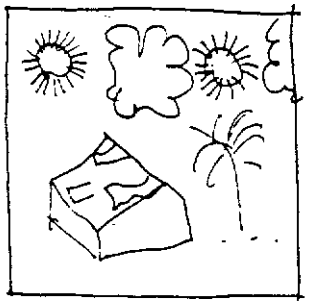


THE WATERPROOFING OF A ROOF
HAS TO BE INSPECTED
FROM TIME TO TIME.

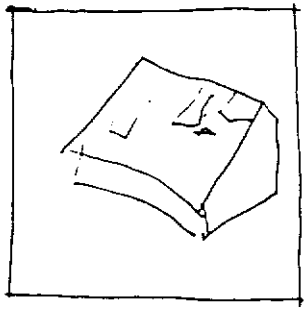


IT SHOULD BE REPAIRED
AT THE SLIGHTEST DAMAGE

AND PARTICULARLY
BEFORE EVERY RAINY SEASON.



WATERPROOFING DETERIORATES
WITH THE SEASONS,



AND, IF NEGLECTED,
IT CAN BECOME MORE OF A NUISANCE

THAN A BENEFIT.

COMMUNICATION CENTRE
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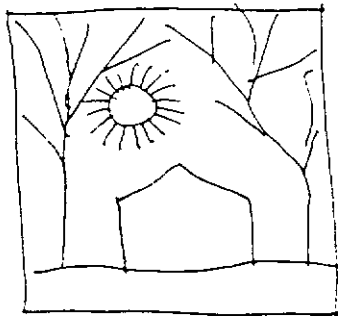
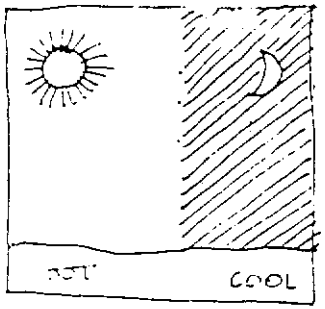
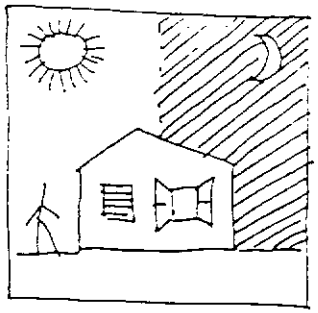
KEEPING THE INSIDE TEMPERATE



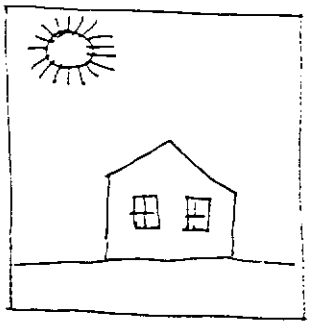


IN A WARM CLIMATE
THE NIGHT IS COOLER
THAN THE DAY.

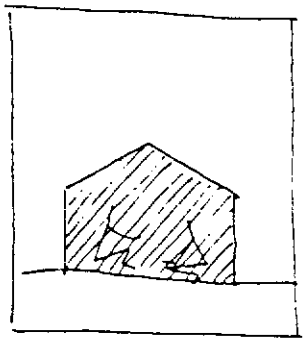


IF YOU ARE ABLE
TO MAKE YOUR HOUSE

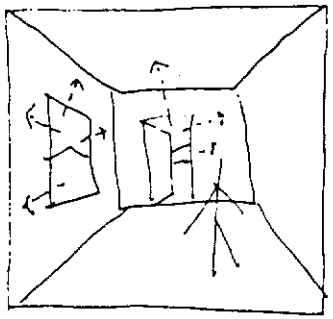
TO RETAIN THE COOL AIR AT NIGHT



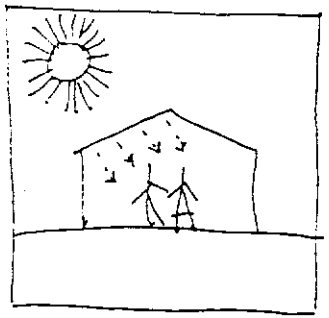
WITHOUT LETTING IN THE WARM AIR
DURING THE DAY,



YOUR HOUSE WILL BE
AN AGREEABLE PLACE TO LIVE IN.

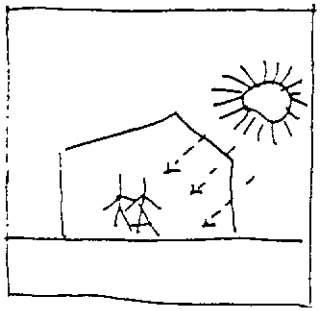


A HOUSE BECOMES HOT
INSIDE

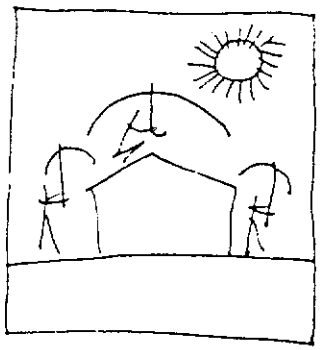


① THROUGH THE HOT AIR COMING IN
THROUGH WINDOWS OR DOORS,

② THROUGH THE HEAT
PASSING THROUGH THE ROOF
EXPOSED TO THE SUN,

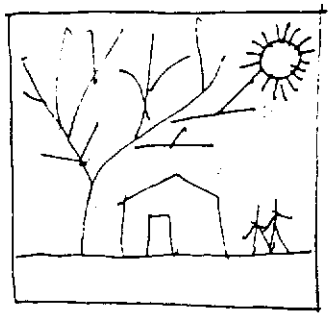


③ AND THROUGH THE HEAT
PASSING THROUGH THE WALLS.



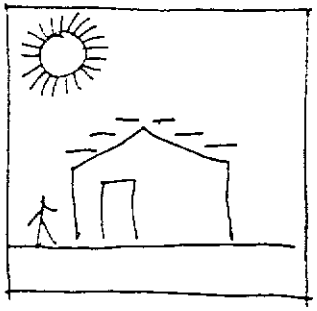
OFTEN, WALLS AND ROOF
STORE THE DAY HEAT
AND DON'T PERMIT THE INSIDE TO
COOL DOWN.

YOU SHOULD, FIRST OF ALL,
PROTECT ROOF AND WALLS FROM HEAT



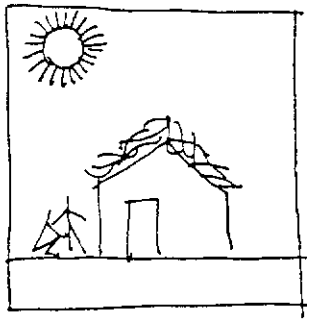
TO KEEP THE ROOF COOL,
THE FIRST THING IS
TO KEEP IT IN SHADE.

FOR EXAMPLE,
YOU CAN BUILD YOUR HOUSE
UNDER A TREE (IF YOU HAVE THE OPPORTUNITY).



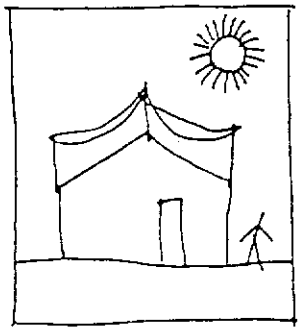
BUT OFTEN IT IS EASIER
TO BUILD A SUNSHADE OVER THE ROOF,
FOR EXAMPLE, BY USING MATS.

(A SUNSHADE
DOES NOT NECESSARILY TO HAVE BE STRONG,
IT HAS TO KEEP SHADOW ON THE ROOF).

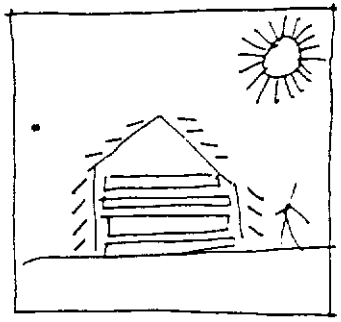


YOU CAN USE AS WELL,
IN ORDER TO SHADOW THE ROOF
ANY MATERIAL
WHICH BLURRS SUNSHINE,

LIKE TWIGS,
THATCH, STRAW, ETC.

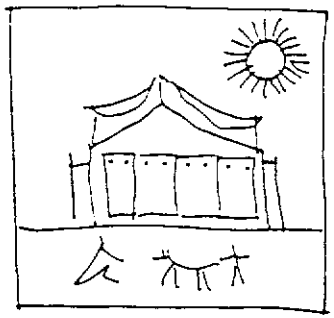


ANOTHER WAY IS TO USE
A SHADOW ROOF,
MADE OF MATS, JUTE
OR SIMILAR STUFF.

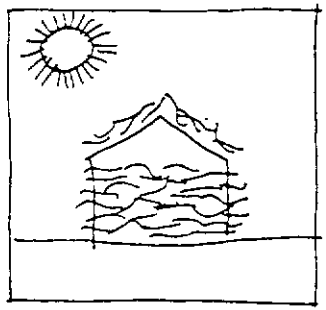


THE SAME TECHNIQUES
CAN BE USED
FOR KEEPING THE WALLS COOL:

SUNSHADES
OUT OF MATS
ALL ALONG THE WALLS,

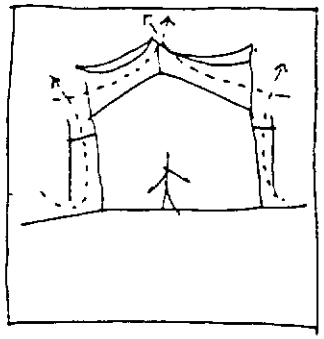


OR CURTAIN-MATS
HANGING A FEW INCHES
IN FRONT OF THE WALLS,



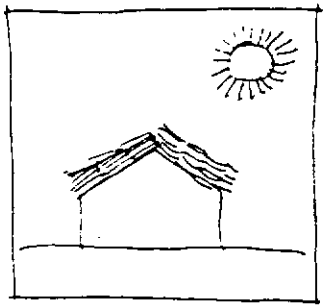
OR SUNSHINE-BLURRING MATERIAL,
LIKE THATCH, STRAW ETC.

(EVEN EMPTY CARDBOARD-BOXES
CAN SERVE FOR THIS PURPOSE).



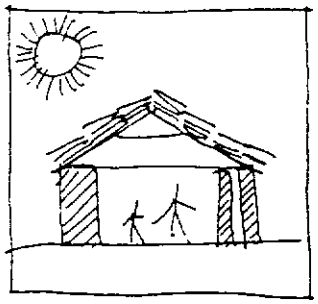
IT IS IMPORTANT,
THAT THE AIR SHOULD
CIRCULATE FREELY,

BETWEEN THE PROTECTING DEVICE
AND THE WALL.

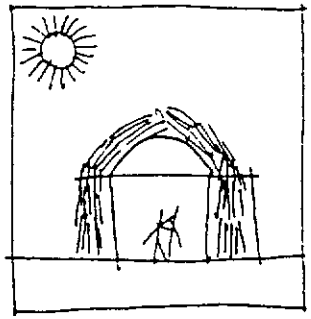


A ROOF OF THICK THATCH
IS A GOOD INSULATION
AGAINST HEAT.

(BUT THE USE OF SUNSHADES
MIGHT BE EASIER AND CHEAPER);

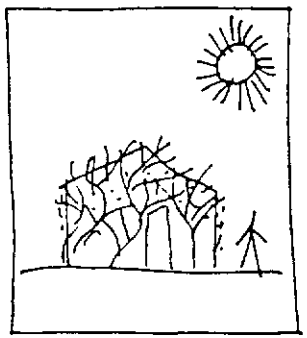


A THICK WALL,
OR A DOUBLE WALL WITH A VOID
BETWEEN THE TWO PLANES,



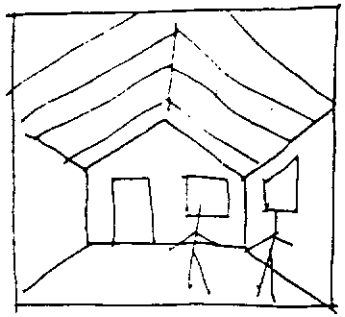
OR ALSO A WALL
MADE OF STRAW OR THATCH
AND PLASTERED WITH MUD,

ARE GOOD FOR INSULATION



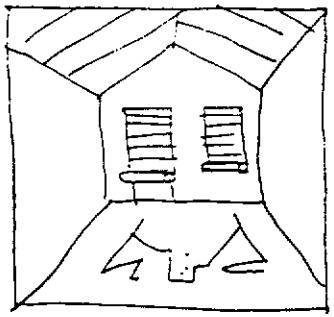
YOU CAN USE CLIMBING PLANTS TOO,
LIKE BEANS, VINES ETC,

WHOSE LEAVES SHADE THE WALL.

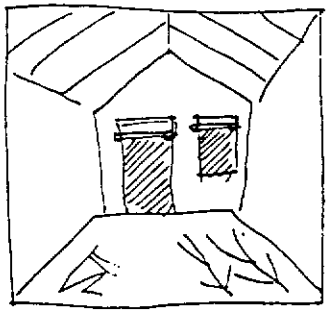


IF WALLS AND ROOFS ARE PROTECTED
AGAINST HEAT,

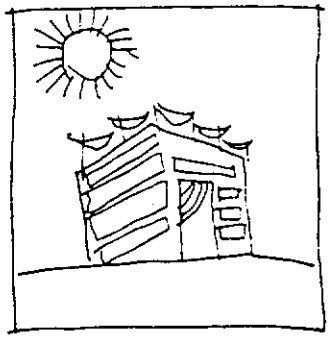
YOU SHOULD PROTECT THE OPENINGS
(WINDOWS AND DOORS) TOO.



A SIMPLE OR DOUBLE MAT-CURTAIN
CAN STOP THE HOT AIR
FROM GETTING INSIDE DURING THE DAY



AND YOU CAN DRAW IT ASIDE
AT NIGHT
WHEN THE AIR IS COOL.



WITH CHEAP MATERIALS,
WITH MATS, STRAW AND THATCH,
YOU CAN MAKE YOUR HOUSE
COOLER

AND MORE PLEASANT TO LIVE IN.

COMMUNICATION CENTRE
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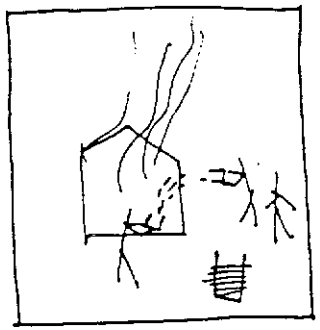
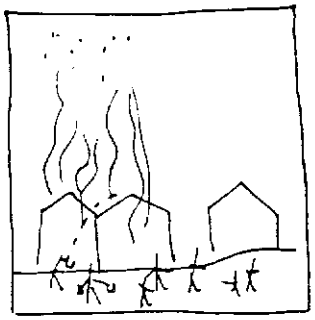
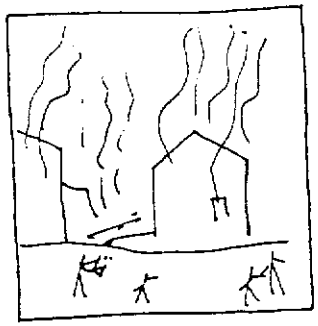
PREVENTING FIRE



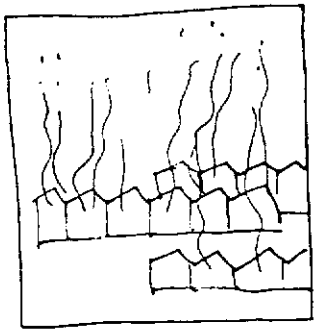


FIRE
IN A NEIGHBOURHOOD

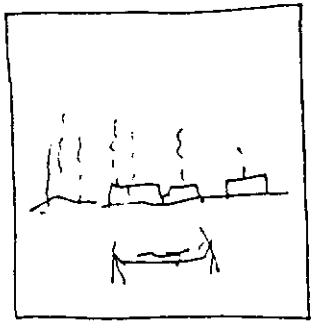
CAN BE A CATASTROPHE:



IT DOES NOT STOP
AT ONE HOUSE
WHICH BURNS DOWN COMPLETELY

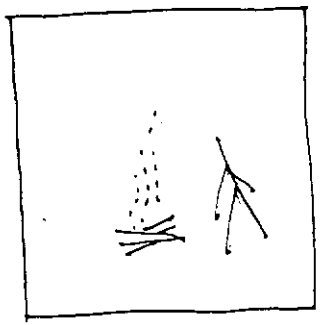


BUT IT RUNS
FROM ONE HOUSE TO THE NEXT.

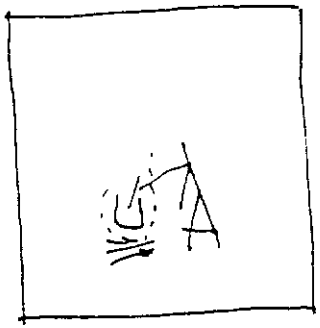


MANY PEOPLE
AND MANY THINGS
CAN BE LOST

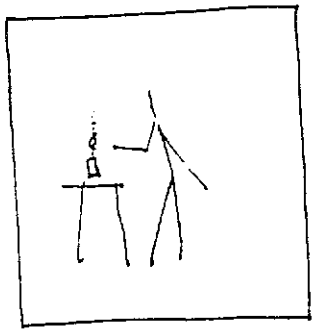
BY ONE BIG FIRE.



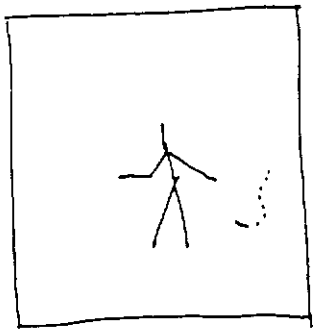
IN ORDER TO PREVENT FIRE
THE FIRST THING TO DO
IS TO TAKE PRECAUTIONS



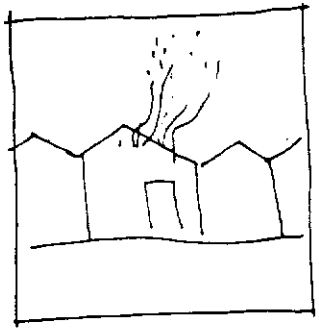
WHILE COOKING,



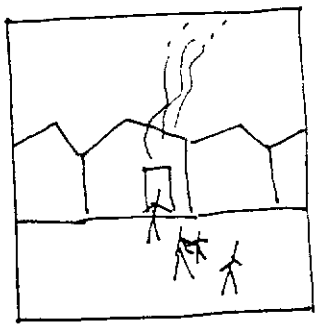
WHILE LIGHTING A LAMP,



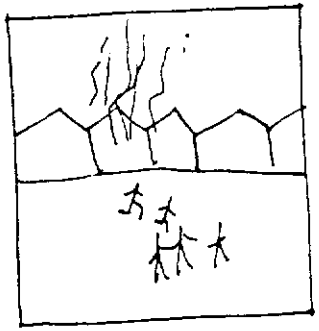
WHILE SMOKING.



WHEN A FIRE BREAKS OUT

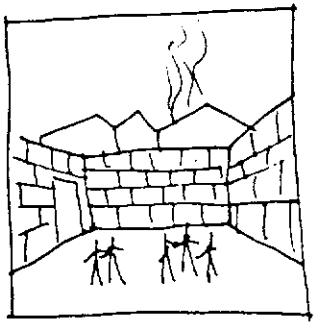


THE FIRST THING IS TO SAVE PEOPLE.



IT IS IMPORTANT, FOR THIS PURPOSE, THAT PEOPLE FROM THE BURNING HOUSE SHOULD BE ABLE TO FLEE

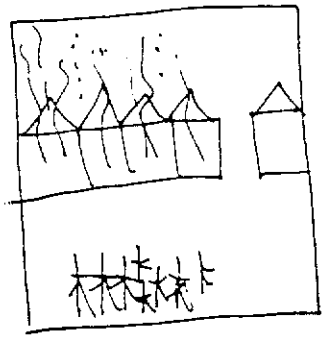
TO A LARGER OPEN PLACE, FOR EXAMPLE,



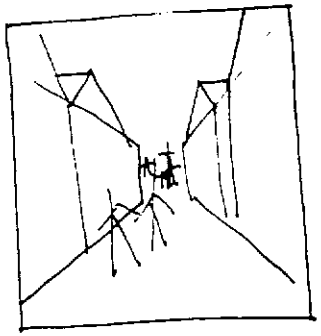
OR TO A PLACE WHERE THE FIRE CANNOT REACH.

SUCH A SPACE CAN BE A SQUARE

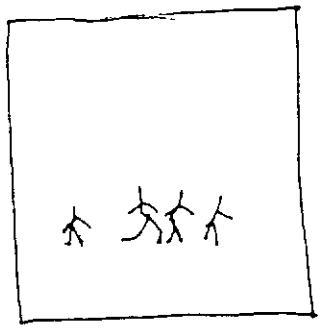
OR A WIDER STREET,



BROAD ENOUGH TO STOP THE PROPAGATION OF THE FLAMES.

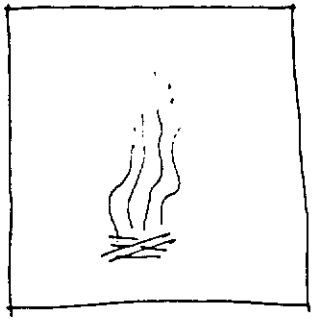


PEOPLE SHOULD BE ABLE TO REACH THIS SPACE EASILY: IT SHOULD BE NEAR ALL THE HOUSES,



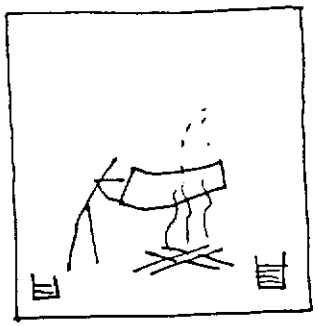
AND IT SHOULD BE CONNECTED TO OTHER SIMILAR SPOTS,

FOR PEOPLE MIGHT NEED TO CONTINUE THEIR FLIGHT.



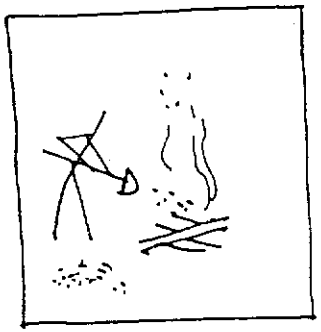
FIRE NEEDS AIR TO BURN.

TO PUT OUT A FIRE
YOU SHOULD CUT AWAY THE AIR.

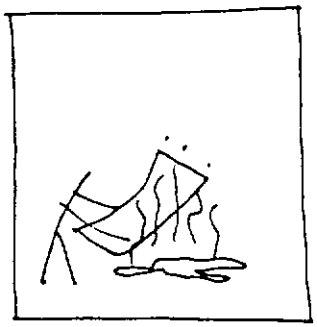


FOR EXAMPLE,
BY THROWING A WET BLANKET
ON THE FIRE,

OR WATER,

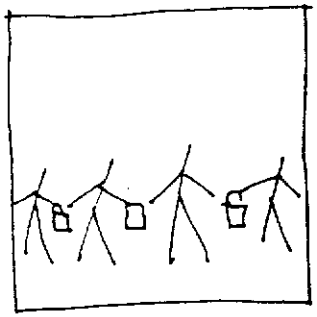


OR EVEN SAND.



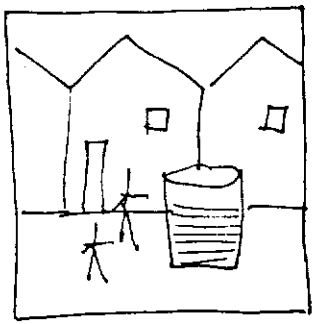
IF PETROL IS BURNING,
THE WATER MIGHT BE USELESS,

BUT A WET BLANKET OR SAND
CAN EXTINGUISH THE FIRE.



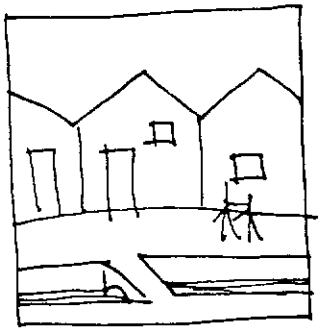
A HANDY WATER RESERVE
IS IMPORTANT

WHEN FIGHTING A FIRE.

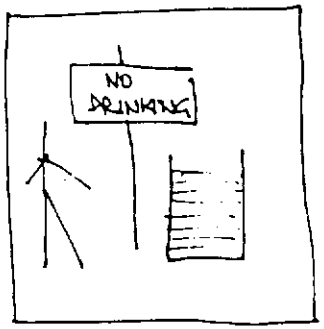


A BARREL FULL OF WATER
IN FRONT OF EACH HOUSE,

CAN DO IT;

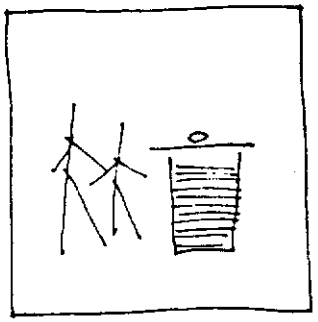


A WATER DITCH ALONG
THE STREET,
CAN BE USEFUL TOO.

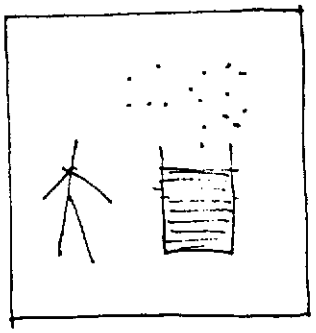


THE WATER FOR PUTTING OUT FIRE
DOES NOT NEED TO BE CLEAN
OR DRINKABLE:

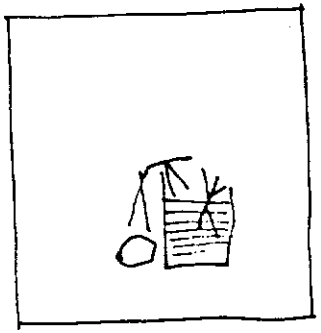
IT SIMPLY HAS TO BE CLOSE AT HAND.



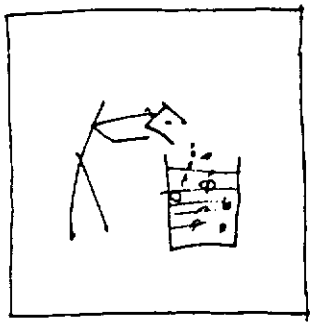
ONE SHOULD KEEP
THOSE BARRELS COVERED



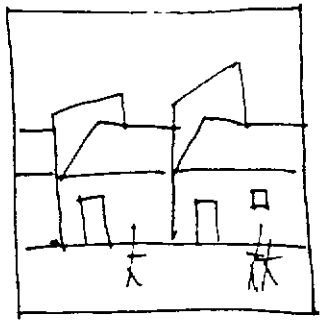
IN ORDER TO KEEP OUT
MOSQUITO LARVAE



OR TO KEEP SMALL CHILDREN SAFE
FROM FALLING INTO THE WATER,

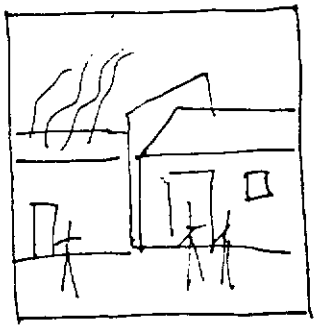


AND FOR PREVENT PEOPLE
USING THE BARREL
AS A GARBAGE DUMP.



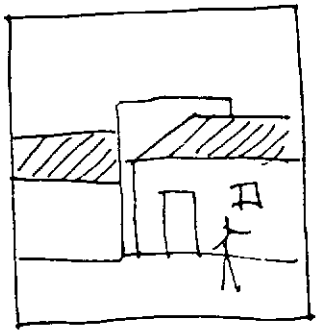
THERE ARE SAFETY PRECAUTIONS
WHICH CAN BE BUILT INTO
THE HOUSE:

FOR EXAMPLE, FIRE WALLS.

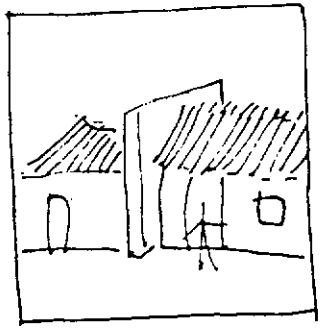


THESE ARE WALLS
SEPARATING TWO HOUSES

AND STOPPING THE FIRE FROM SPREADING.

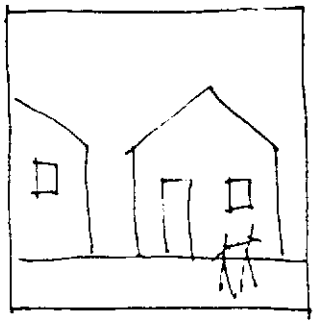


SUCH A WALL HAS TO BE
SUBSTANTIALLY HIGHER
THAN THE ROOFS



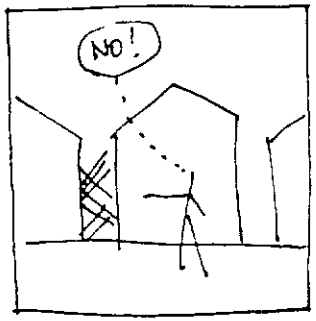
AND IT HAS TO BE MADE
OF FIREPROOF MATERIALS

SUCH AS
STONE, BRICKS
OR SUN DRIED MUD.



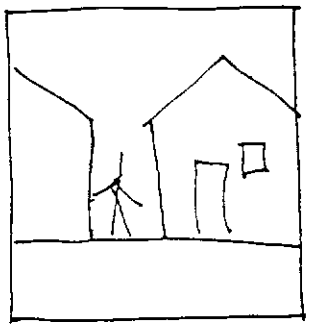
IF YOU HAVE SOME SPACE
SEPARATING TWO ADJOINING HOUSES.

IT CAN BE SOMETIMES USEFUL,

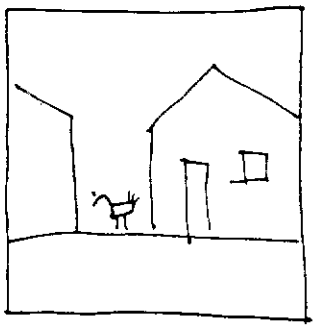


BUT ONLY IF YOU DONT USE IT
FOR STORING
INFLAMMABLE MATERIALS

LIKE FIREWOOD,

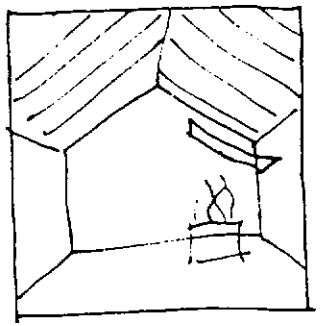


PAPER,
CLOTHES, ETC-



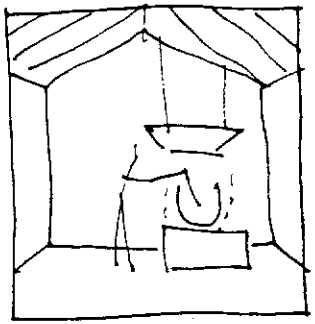
BUT IT IS NOT DANGEREOUS
TO KEEP
SMALL DOMESTIC ANIMALS
IN THIS SPACE

LIKE HENS, DUCKS ETC.

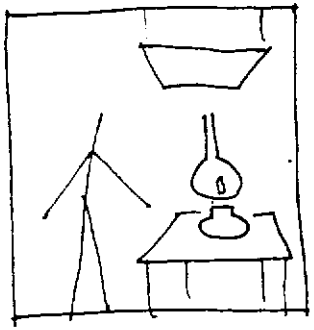


INSIDE THE HOUSE
SECURITY CAN BE INCREASED TOO,

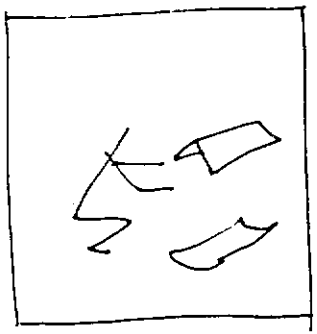
BY PROTECTING THE ROOF
FROM FLAMES WHICH MIGHT REACH IT.



YOU CAN MAKE, FOR EXAMPLE
A METAL HOOD
ABOVE THE COOKING SPACE

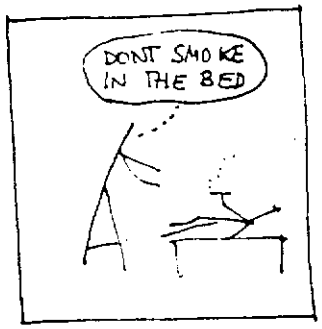


OR ABOVE LAMPS
AND ABOVE ANY OPEN FLAME.



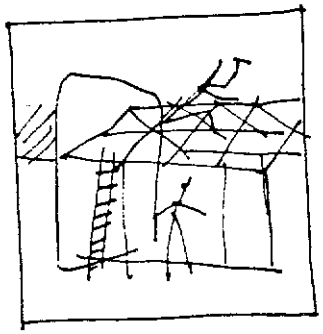
SUCH A HOOD CAN BE MADE
FROM SCRAP METAL
LIKE FOOD - TINS OR BARRELS.

IT WILL KEEP AWAY HEAT
FROM THE WOODEN ROOF.



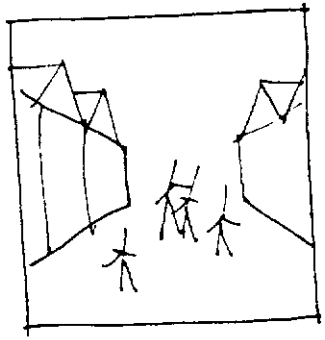
PROTECTING ONESELF FROM FIRE BEGINS

WITH PRECAUTIONS AT HOME.

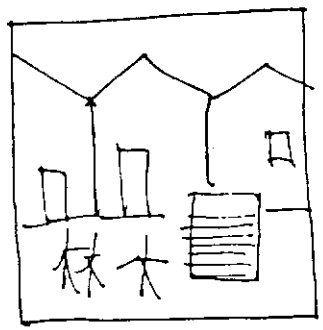


IT CAN BE IMPROVED WITH FIRE PREVENTION DEVICES

LIKE FIRE WALLS OR ALLEYS BETWEEN HOUSES.



EASY WAYS TO FLEE INTO SAFETY ARE VERY IMPORTANT,

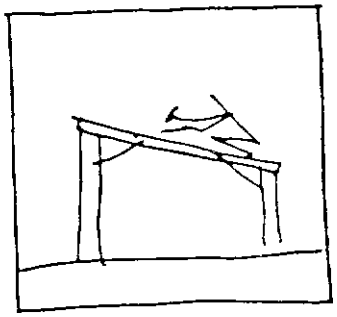


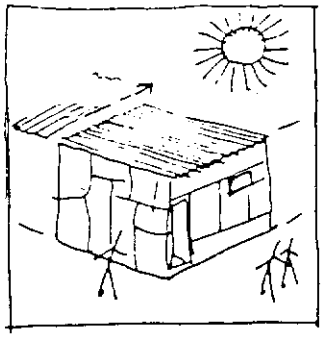
AND ABOVE ALL, A HANDY WATER BUTT.

COMMUNICATION CENTRE
OF SCIENTIFIC KNOWLEDGE FOR SELF-RELIANCE

UNDER THE AUSPICES OF THE UNITED NATIONS UNIVERSITY
WITH THE PARTICIPATION OF THE INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

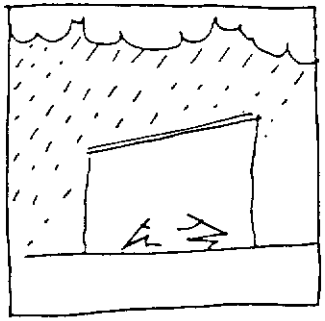
IT IS IMPORTANT
TO IMPROVE YOUR ROOF



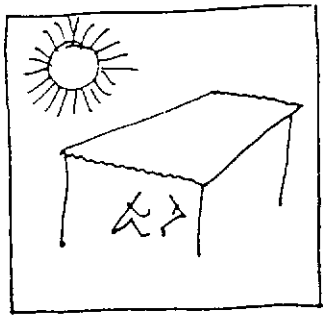


A ROOF
MADE OF CORRUGATED IRON SHEETS
(OR OUT OF SIMILAR MATERIALS)

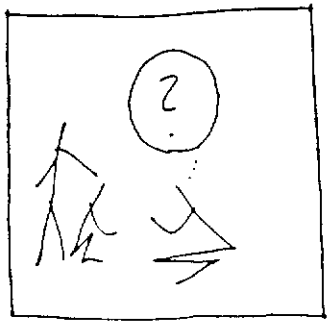
BECOMES VERY HOT IN SUMMER AND



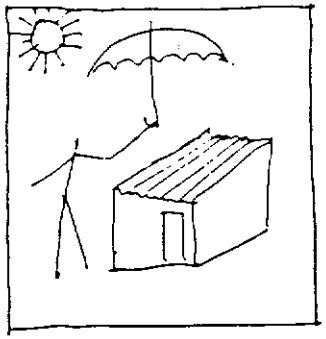
CAN BE COLD IN WINTER.



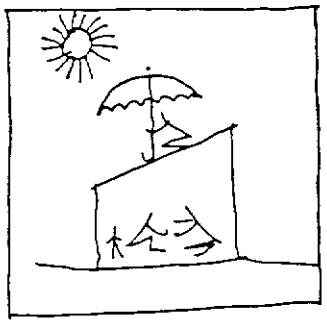
A ROOF MADE OF THIN SHEETS
LETS IN
HEAT AND COLD.



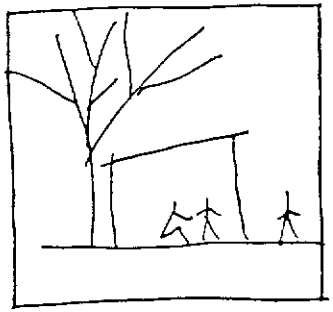
HOW TO PROTECT THE ROOM UNDER IT
FROM HEAT AND FROM COLD?



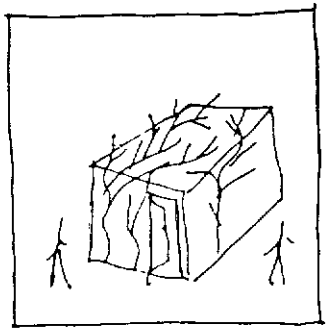
IF YOU COULD KEEP YOUR ROOF
(MADE IN THIN SHEETS)
IN THE SHADE



THE ROOM UNDER SUCH A ROOF
WILL BE LESS HOT IN SUMMER.

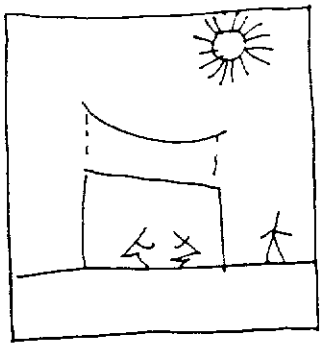


IF YOUR ROOF, FOR EXAMPLE,
IS PROTECTED BY THE SHADOW
OF A TREE,

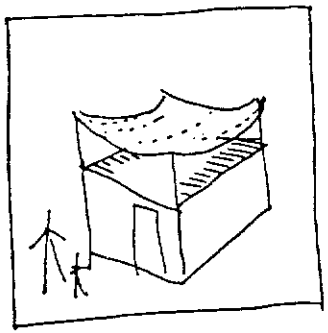


OR BY A CLIMBING PLANT
WHICH COVERS THE ROOF,

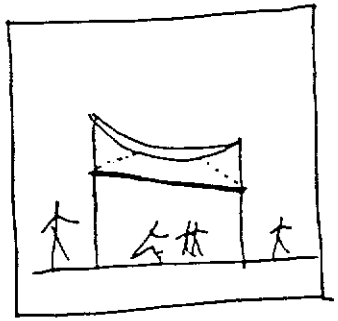
YOUR HOUSE WILL BE MORE TEMPERATE.



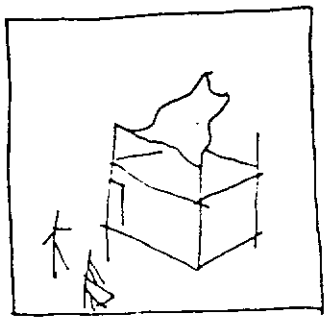
ONE COULD REALLY HAVE AN "UMBRELLA ROOF" OVER ONE'S ROOF



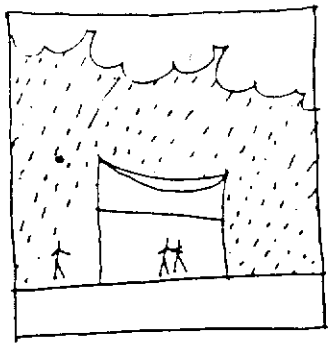
IT COULD BE MADE OUT OF MATS SUSPENDED ON A FEW POSTS, DISPOSED AROUND THE ROOF,



AND BE FIXED WITH SOME ROPES



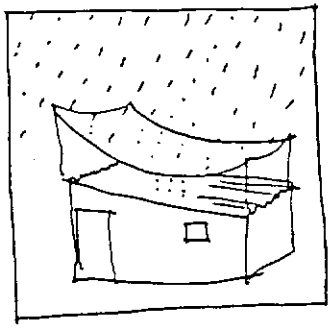
AGAINST THE WINDS.

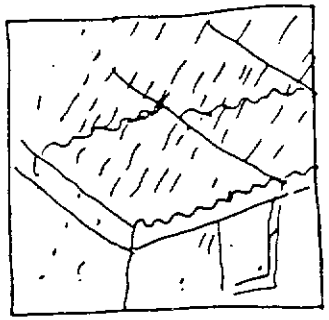


THE "UMBRELLA ROOF" PROTECTS THE REAL ROOF

AGAINST RAIN TOO,

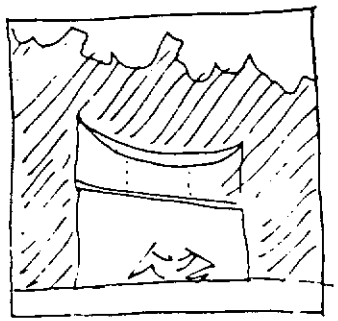
EVEN IF IT IS NOT WATERPROOF ITSELF.





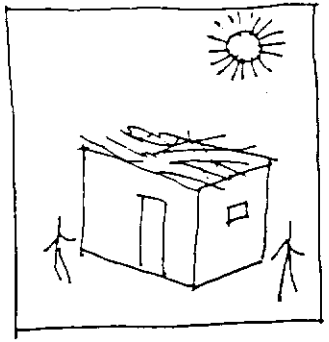
USUALLY HEAVY RAIN HAS A FORCE, AND WHEN BEATING THE ROOF IT COULD ENTER INTO THE ROOM

THROUGH THE JOINTS.

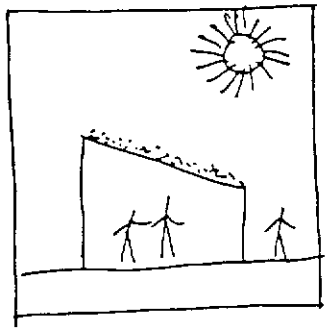


THE "UMBRELLA ROOF" WHEN LETTING THROUGH THE RAINWATER (AS MATS DO) LESSENS MUCH ITS FORCE

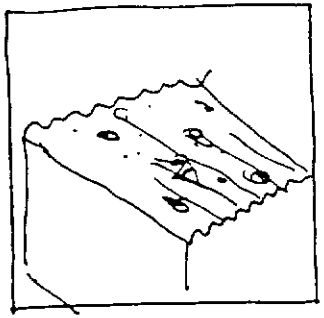
AND YOUR REAL ROOF WILL LEAK LESS.



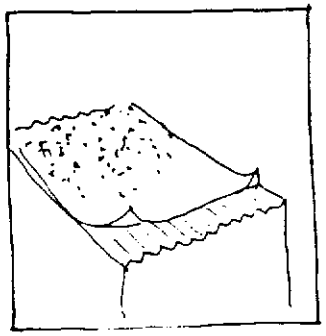
ONE CAN PROTECT
A ROOF IN CORRUGATED IRON SHEETS
AGAINST HEAT AND COLD



BY DISPERSING
A PROTECTIVE LAYER OF EARTH
OR OF SAND AND PEBBLES ON IT.

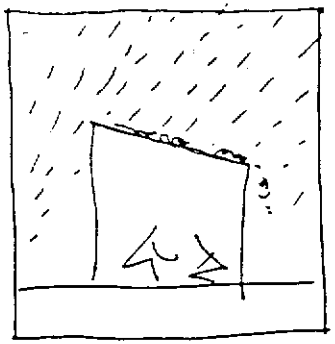


FOR THIS
YOU HAVE TO PROTECT THE SHEET
AGAINST CORROSION



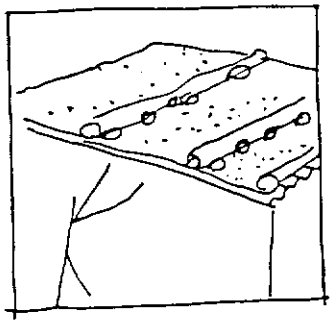
BY HAVING A THIN PLASTIC FOIL
UNDER THE LAYER,

ISOLATING THE LAYER FROM THE ROOF.

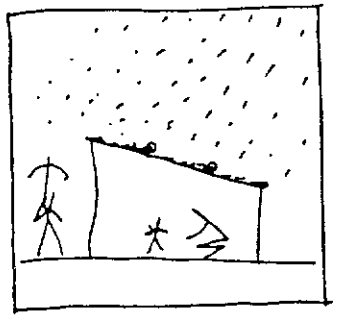


IF THE ROOF IS SLOPING
(AS IT SHOULD BE
FOR WATER RUN-OFF

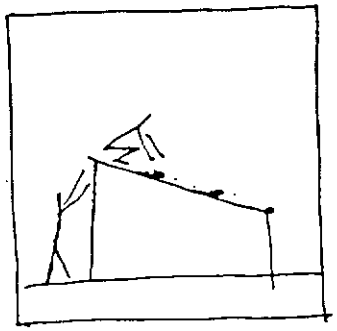
YOU SHOULD ENSURE
THAT THE LAYER STAYS IN PLACE.



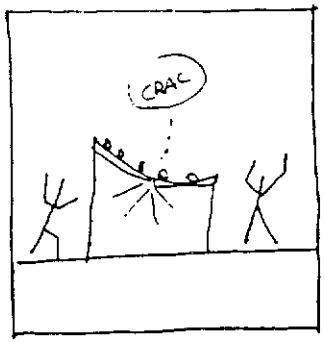
IF YOU MAKE FOLDS IN THE PLASTIC,
FOLDS FILLED WITH PEBBLES, FOR EXAMPLE,



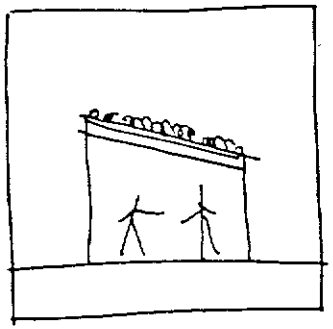
THEN THE RAIN WATER
WILL NOT WASH AWAY THE PROTECTIVE LAYER



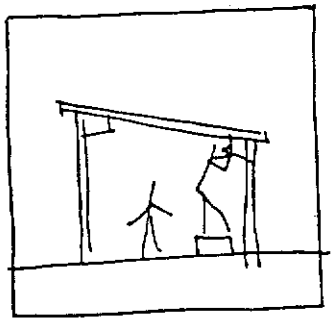
BUT YOU SHOULD REPAIR IT
AFTER HEAVY RAINFALL.



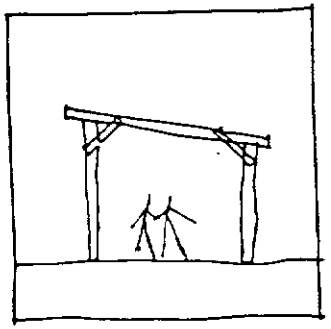
IF YOUR ROOF HAS TO SUPPORT THE WEIGHT OF SUCH A LAYER (EARTH OR PEBBLES ARE HEAVY)



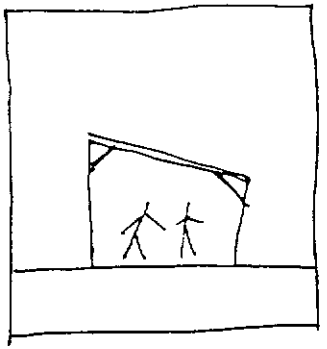
YOU HAVE TO MAKE THE BEAMS STRONGER.



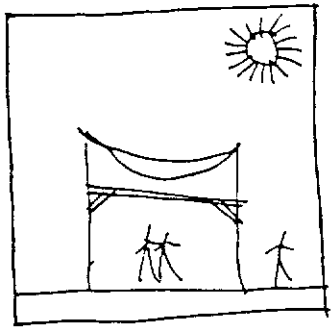
YOU CAN DO THIS BY FIXING PIECES OF WOOD LINKING BEAMS TO THE POSTS.



THE BEST WAY IS THAT THE REINFORCING PIECES SHOULD FORM A TRIANGLE WITH BEAMS AND POSTS.

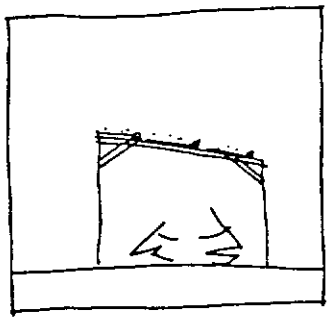


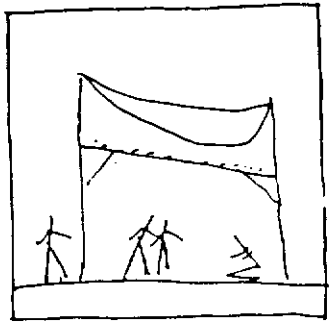
A STRONG ROOF



WHICH IS WELL PROTECTED BY AN "UMBRELLA ROOF"

OR BY A LAYER OF EARTH.





CAN MAKE YOUR HOUSE A BETTER PLACE

IN SUMMER AND WINTER.